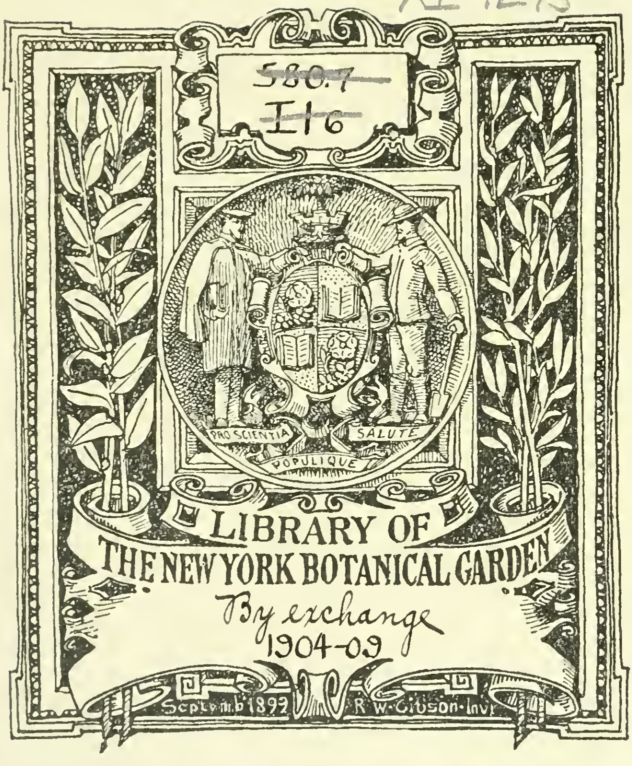
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Bulletin

of the

Illinois State Laboratory

of

Natural History

Urbana, Illinois, U. S. A.

VOLUME VII.

1904–1909

Contributions to the Natural History Survey of Illinois
made under the direction of

Stephen A. Forbes

1910
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CONTENTS.

ERRATA AND ADDENDA.

Page 55, line 15, for *1854* read *1855*.

Page 55, line 16, for *Horticultural* read *State Agricultural*.

Page 60, in second table, Illinois, for *240* read *241*.

Page 65, first line above foot-note, for *ventricosa* read *ligamentina*.

Page 72, line 9, for *imbecilis* read *imbecillis*.

Page 79, line 19, for *asperimus* read *asperrimus*.

Page 80, above *Quadrula rubiginosa* insert Section *Fusconaia* Simpson.

Page 76. The record of Calkins for *Margaritana margaritifera* is without doubt erroneous and should be eliminated. This species is not found in Illinois.

Page 95. *Pomatiopsis sheldonii* Pilsbry should read *Amnicola sheldonii* and should be transferred to the genus *Amnicola* on page 93.

Page 100. *Physa gyrina oleacea* Tryon is the immature stage of *Physa gyrina*.

Page 103. *Lymnæa tazewelliana* is a synonym of *Lymnæa parva*.

Page 105. *Lymnæa palustris michiganensis* is the immature form of *Lymnæa reflexa*.

Page 106. *Lymnæa reflexa iowensis* and *Lymnæa reflexa crystalensis* are synonyms of *Lymnæa reflexa*.

Page 112, line 6 from bottom, for *gouldi* read *gouldii*.

Page 114, line 5 from bottom, for *juxtigens* read *juxtidens*.

Page 115, line 21, for *Witter* read *Walker*; line 23, *Polygyra sayii* Binney should be changed to *Polygyra sayana* Pilsbry.

Page 116, line 1. *Polygyra exoleta* Binney (1885) should be changed to *Polygyra zaleta* Binney (1837).

Page 117, line 11 from bottom, for *leai* read *leaii*; line 3 from bottom, *Polygyra monodon fraterna* is a good species and should read *Polygyra fraterna*.

Page 119, foot-note. A specimen of *alliarius* in the collection of Mr. Aldrich, received from Calkins, proves to be *draparnaldi*.

Page 121, line 3 from bottom, for *Champaign* read *Piatt*.

Page 122, line 12 from bottom, for *Pyramidula striatella* Anthony read *Pyramidula cronkkitei anthonyi* Pilsbry; line 4, for *Held* read *Hald*.

Page 123, for *Helicodiscus lineatus* Say read *Helicodiscus parallelus* Say.

Page 162, line 7, for *glandulosa* read *linearis*.

Page 171, line 17, for *riparia* read *vulpina*.

Page 176, line 8 from bottom, for *canadense* read *majus*.

Page 180, line 9, for *virginica* read *virginiana*.

Page 221, line 6 from bottom, for *rectangulus* read *rectangularis*.

Page 226, line 3, for *fasciatus* read *fasciata*.

Page 239, line 11, strike out Lake Co. entry.

Page 246, lines 6 and 7, and page 248, lines 1, 14, 20, and 23, for *Œnothera* read *Onagra*.

Page 248, line 4, for *candida* Horn substitute n. sp.

Page 249, line 8 from bottom, for *Olethreutes dimidiana* Sodoff? read *Olethreutes separatana* Kearfott, and strike out parenthetical matter.

Page 251, line 7, for *grossa* read *thoracica*; line 21, for words preceding H. 6, read *Asilus rufipennis* Hine; line 18 from bottom, for words preceding H. 2, substitute *Asilus cacopilogus* Hine.

Page 253, line 8, for *Linn.* read *Emory*.

Page 257, line 15, for *pennsylvanicus* DeG. read *auricomus* Rob.

Page 261, Note 6. *Melanoplus macneilli* is very probably *M. fluviatilis* Brun.

Page 262, Note 9. Dr. Bergroth writes that *Nabis elongatus* is preoccupied. The original is *elogantus* in the check list. Comparison with long-winged *vicarius* is desirable before re-naming it.

Page 309, in table, for *59* read *57*, and for *743* read *741*.

Page 310, in table, for *59* read *57*.

Page 314, line 5, for *1587* read *481*; line 16, after *stubble* insert *meadows*; line 17, after *pastures* strike out *and meadows*, and after *1500* strike out *each*.

Page 315, last line, for *553* read *481*.

Page 362, line 7 from bottom, for *longa* read *parvilamellata*.

Page 373. As a second entry in synonymy insert as follows:

1854. *Nothrus bistriatus*, Nicolet, Acariens des Environs de Paris, p. 397, Pl. VII., Fig. 7.

Page 376, line 13 from bottom, for *Oribata* read *Oribates*.

Page 378, line 1, for *XXV.* read *XXXV.*

Page 384, after line 5 insert as follows:

N. bipilis Hermann. Mem. Apt., p. 95.

In moss, Arcola and Parker, Ill.

Page 384, line 5 from bottom, for *pyrostigma* read *pyrostigmata*.

Page 386, after line 11 from bottom insert as follows:

H. bistriata Nicolet. Acariens des Environs de Paris, p. 397, Pl. VII., Fig. 7.

Under logs and in moss, Urbana and Arcola, Ill.

Page 388, line 12, for *sphærulum* read *sphærula*.

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BULLETIN

OF THE

ILLINOIS STATE LABORATORY

OF

NATURAL HISTORY

URBANA, ILLINOIS, U. S. A.

VOL. VII. FEBRUARY, 1904 ARTICLES I.-II.

ART. I. STUDIES OF THE LIFE HISTORY, HABITS, AND TAXONOMIC RELATIONS OF A NEW SPECIES OF OBEREA (OBEREA ULMICOLA CHITTENDEN).

ART. II. STUDIES OF THE HABITS AND DEVELOPMENT OF NEOCERATA RHODOPHAGA COQUILLETT.

BY

F. M. WEBSTER, M.S.

Article I.—*Studies of the Life History, Habits, and Taxonomic Relations of a New Species of Oberea (Oberea ulmicola Chittenden).* By F. M. Webster.

The species of this genus of *Cerambycidæ* are not easy to define, on account of their variability in color, and they have for this reason been the subject of repeated and radical revision by entomologists. In 1878, Dr. G. H. Horn, in his revision of the genus* restricted the number of species to eleven, while Mr. Chas. W. Leng, eighteen years later, reduced this number to five. In this latter revision *Oberea tripunctata* Swederus was divided into two groups, or forms as they are there called, the *bimaculata* form and the *tripunctata* form, the species itself being thus burdened with no less than eleven synonyms. Even this arrangement is unsatisfactory, and considerable evidence has accumulated tending to show that we may have species the adults of which are difficult to separate, whose larvæ are restricted to very different food plants. Thus *Oberea bimaculata* has hitherto been reared exclusively from plants belonging to the genus *Rubus*, while *O. tripunctata* breeds in a variety of food plants other than *Rubus*, and including the elm. It is therefore interesting to find another apparently valid species which seems restricted to the elm, although *O. tripunctata*, as at present understood, breeds on the same tree with the one under consideration.

One of its close allies, *Oberea texana*, is a southern form, while *O. ulmicola* has thus far been found only in a single city of about 20,000 inhabitants in central Illinois. Even there it does not infest the elms of the entire city, but has confined itself to a certain section, within which it is so excessively abundant that the females are compelled to deposit their eggs in the same twigs again and again, notwithstanding the fact that only

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*Trans. Am. Ent. Soc., Vol. VII., pp. 45–48.

†*Loc. cit.*, Vol. XXIII., pp. 153–157.

a single larva can survive in each twig. This congestion in numbers and restricted distribution would commonly be taken to indicate a spirit of mutual toleration bordering on gregariousness. In this case, however, if adults of both sexes are confined at all closely together they will, regardless of sex, fall upon each other, amputating antennæ and legs with a savagery like that of the most bloodthirsty quadruped, and this vicious disposition is, in fact, one of the greatest obstacles to the close study of these insects in confinement.

These studies are based very largely on the acute and untiring observations of Mr. E. S. G. Titus, formerly Assistant to the State Entomologist of Illinois and now an assistant in the Division of Entomology of the United States Department of Agriculture. The species was from the first regarded by him as probably new, and later, in connection with my own studies of insects infesting shade and ornamental trees, specimens were submitted to Dr. L. O. Howard for identification, which revealed the fact that it was not represented in the collections of the Department of Agriculture, or in those of the United States National Museum. As Mr. F. H. Chittenden, of the Division of Entomology of the Department of Agriculture, had already collected considerable material for a study of the genus *Oberea*, he was invited to describe the species, and his description of the adult follows, together with a table prepared by him showing the relations of the species in the genus.

DESCRIPTION OF THE SPECIES.

The Adult.

"While studying reared material of the genus *Oberea*, and referring to published accounts of the species, it was observed that in many references to economic literature the raspberry cane-borer was called *Oberea tripunctata* Fabr. as well as *O. tripunctata* Swed. It has been conceded by Horn and others that the former name is synonymous with *O. bimaculata* Oliv., which, the writer is convinced, is quite distinct from *O. tripunctata* of Swederus. We have recently had considerable correspondence

with Prof. F. M. Webster, who has also reared these two species, as well as a third, and as his views correspond with the writer's, a table has been drawn up, after careful comparison of nearly a hundred examples of the first two species discussed and a lesser number of the third.

"As a preliminary, it should be stated that the writer fully concurs in the views expressed by Dr. Horn* when he stated that the table furnished at that time, 1878, although founded on color characters, attained 'the object in view as nearly as can be done'; also that the *species* were so variable, even with the suppression which he had made, 'as almost to resist generalization'.

"The first two forms considered can readily be distinguished by color characters alone, examination of all available material showing these colors of sufficient constancy to leave no doubt as to the specific identity of a single specimen. Moreover, the three species are physiologically distinct, being constant within certain limits as regarding habits, *O. bimaculata* having thus far been reared only from canes of raspberry and blackberry (*Rubus*), *O. tripunctata* from various deciduous trees, including dogwood (*Cornus*) and witch-hazel, while the third species is known only as inhabiting the elm (*Ulmus*). The three species now under discussion may be separated by the aid of the following table:

A. Ventral surface (including legs and antennæ) except thorax, black; abdomen somewhat coarsely and very sparsely punctate, with rather long, black or dark brown pubescence.

  Elytra with black pubescence, disc with prominent carinæ, and deeply and closely punctate.

    Head somewhat strongly and densely punctate, with moderately black, brown, or dark yellow pubescence. . . . . *bimaculata* Oliv.

AA. Ventral surface (including legs) largely yellow; abdomen with punctuation feeble, obsolete, or wanting on some segments; pubescence short and pale.

*Loc. cit.

Elytra with cinereous or griseous pubescence; disc more flattened, with less prominent carinæ, less strongly punctate.

Head less strongly and more sparsely punctate, more strongly pubescent with gray or yellow.

a. Form slender, antennæ long; head, antennæ, and elytra mostly black, with cinereous pubescence; elytra moderately, finely, and sparsely punctate................ *ulmicola* Chittn., n. sp.

aa. Form more robust, antennæ shorter, black, or partly yellow; head with yellow or griseous pubescence; elytra largely yellow, more strongly and densely punctate, with very pale yellowish or griseous pubescence. *tripunctata* Swed.

"*Oberea ulmicola* Chittenden, n. sp. (Pl. I., Fig. 1.)

"Form slender. Head, antennæ, and elytra black, with gray pubescence, becoming long and dense on the head, nearly obscuring the punctures, and darker plumbeous-gray on the thorax. Antennæ slender, long, five-sixths of the length of the entire insect. Head somewhat feebly and sparsely punctate, with strongly defined median line, especially in the posterior portion. Thorax yellow, callosities black, occasionally with a smaller black antescutellar spot on each side; just above the leg there is usually another variable black spot, either smaller or much larger than the others. Elytra with basal portion on each side of and including the scutellum, yellow, occasionally with a longitudinal yellow streak on each elytron, extending from the base nearly to the apex, which is emarginate and sub-bidentate; the surface comparatively sparsely and feebly punctate. Epipleuræ yellow. Ventral surface usually yellow, but occasionally with a portion of the thorax and of the second and third abdominal segments and less frequently the first and last segment, black. Punctuation very shallow, nearly obsolete

on abdominal segments. Proximal portion of legs yellow, distal portion black. The sexual and other characters as far as observed differ but slightly from those of *tripunctata* and *bimaculata*.

Length, 9–13 mm.; width, 1.2–2.0 mm. Average length, 12 mm.; width, 1.9 mm. The small specimens are obviously stunted.

"Habitat, Decatur, Illinois, where it breeds in twigs of the American elm, *Ulmus americana*. Described from many specimens reared by Mr. E. S. G. Titus and collected by himself and Mr. Webster.

"Type, No. 6981, U. S. National Museum. Kindly presented by Dr. S. A. Forbes, Director of the Illinois State Laboratory of Natural History.

"This species has a somewhat strong resemblance, in dark individuals, to *O. bimaculata*, while the pale forms approach *O. tripunctata*. In reality it is nearer *O. texana* in appearance, but has longer antennæ than any of these. *O. texana* is quite distinct in having the paler parts, thorax, and ventral surface red, epipleuræ black, proximal portion of the legs reddish, head less hairy, and abdomen comparatively strongly punctate."

At present it does not appear possible to separate the early stages of this group of species. While there are obscure differences, there do not appear to be the necessary positive ones.

The Egg. (Pl. I., Fig. 2.)

Length, 3 mm.; width, 0.6 mm.; slightly reniform, of a creamy white color, without perceivable reticulations.

The Larva. (Pl. I., Fig. 3.)

Length, 14 mm. Head much smaller than thoracic segments, body decreasing in width posteriorly with moderate uniformity to the eighth segment, which is considerably smaller, the anal still more reduced; body light straw-color, the two posterior segments lighter; head anteriorly dark brown, posteriorly the color of the body, mandibles darker than anterior portion of head. Cervical shield brownish yellow, anterior surface smooth polished, terminating posteriorly in a slightly raised, transverse ridge. The apical declivity is shagreened, more finely posteri-

orly and centrally; narrow median dorsal area whiter; lateral oblique, sinuate grooves darker. In front of the shagreened area are a few short erect hairs, with larger ones placed laterally on this segment. On the next segment there are but two lateral hairs on each side, and none on other segments until the eleventh, which has a single stout bristle on each side considerably above the margin, and a transverse row of hairs along the posterior margin. The anal segment has a considerable number of long curved hairs along the lateral and posterior areas. The lateral margins of each of the abdominal segments, just below the spiracles, have an inflated appearance, and segments three to ten inclusive are strongly sculptured, especially on the dorsal surface, by transverse, tubercular, flattened ridges which are minutely shagreened. The sculpture of these is clearly shown in Fig. 3, Pl. I. The lateral inflations, with deep intervening constrictions, give the larva when extended a somewhat moniliform aspect.

The Pupa. (Pl. I., Fig. 4.)

Length, 13 mm.; color uniformly light yellow; head with nearly triangular impressed area between the bases of the antennæ, on each side of which are a pair of closely set hairs. There are two clusters of minute spinules on the clypeus. The antennæ, being abruptly bent downward, give the head a decidedly square appearance. They extend backward to just beyond the middle femora, where they turn forward along and outside of the anterior and middle legs, the posterior pair of legs being folded under the wings. There is a minute, robust, hooked spine on the marginal ridge of each of the abdominal segments except the terminal, the hooks being reversed; there is also on each of these segments a transverse dorsal elevation armed with irregularly placed, minute, stout spines. The terminal segment is provided with a number of long hairs.

LIFE HISTORY.

There is a single annual generation, the larvæ hibernating in the twigs and finishing their development in the spring, the

larval period being nearly eleven months. Pupation takes place within the twigs during late April and early May, the pupal period occupying from 22 to 29 days. The eggs are deposited, in the vicinity of lat. 40°, in Illinois, from about May 20 to June 15. The egg period is from 5 to 7 days.

METHOD OF OVIPOSITION.

As observed by Mr. Titus, the female first girdles the tender growing twig by cutting, with her jaws, a deep groove entirely around it. The twig is then easily detached, and falls to the ground with the first light breeze that occurs. Retreating about an inch along the remaining portion of the twig, the beetle cuts a short longitudinal slit in and through the bark but not entering the wood, and at the lower end of this she cuts a shorter transverse gash, also extending only through the bark. She now pushes the tip of her abdomen under the bark at the angle formed by the two gashes she has made, usually to the right of the longitudinal slit but sometimes to the left, and places her egg snugly under the young tender bark, sometimes nearly a fourth of the way around the twig, where it can be easily detected by the slight elevation thus caused. Having placed her egg, she now retreats still further toward the base of the twig, usually about an inch, and here girdles it a second time, but cutting only to the wood, thus crippling the twig without killing it. If the same female deposits more than one egg in the same twig, she does it at different times, the evident intention being to place them singly, one in each twig, and as shown in Plate I., Fig. 2.

HABITS OF THE LARVA.

The young larva, on first hatching from the egg, begins to feed even before it has entirely emerged, gnawing a minute channel toward the base of the twig and under the bark long enough to enable it wholly to withdraw the body from the egg-shell. It then seems to back up into the abandoned shell and cuts a minute circular hole in the bark directly in line with the channel. Up to this time all of the castings have been pushed

back into the egg-shell, but now they are pushed out through the circular hole thus made. Working now down the center of the twig and continually enlarging its burrow, the larva provides at intervals similar but larger vents in the walls for the same purpose. In this species these holes for the disposal of excreta and waste material do not appear to be as frequently cut as in the case of allied species, the distance from one to another ranging in our specimens from a little over an inch to more than two inches.

Several years ago, while studying similar habits of what I then supposed to be *Oberea bimaculata*, but now know to have been *O. tripunctata*, I observed these holes to occur frequently not more than an inch apart, and the excreta were pushed through and fell down in more or less continuous sections. In two cases the masses of excreta thus disposed of by a larva of that species nearly full grown and about an inch in length during the twenty-four hours, were kept and carefully measured. Their length amounted to the astounding total of twenty-four and three eighths inches, showing that each hour of the day and night the larva had voided a stool greater than its own length,—a fact which gives some idea of the enormous amount of food eaten within that time.*

As the larva increases in size it frequently reverses its position in its burrow, and moves up and down at will. These journeys are easily accomplished by the simple contraction and expansion of the segments of its body aided by the shagreened areas on the dorsal surface. Just prior to pupation, the larva gnaws out a cavity in the wall of its burrow similar to that constructed for the disposal of the excreta, except that it does not penetrate the outer bark. An avenue of escape is thus provided for the adult beetle without exposing the pupa. Pupation occurs within the burrow, and only a few minutes are required for the escape of the beetle from the pupal envelope.

Secure as they may appear to be in their channels, the larvæ are not without their troubles, for not only the main

*Journ. N. Y. Ent. Soc., Vol. V., pp. 202–203, Pl. X., Fig. 1 and 2.

twig is inhabited but the laterals as well, and there may thus be several larvæ, each in its individual twig, pushing downward to the base, in which but one of them can survive. The one that is foremost in this blind race, as it passes below its fellows cuts off their food supply and leaves them to perish in their homes. In some instances larvæ have been observed to pass the whole length of water-shoots and for a short distance into the wood of the tree itself.

The effect on the trees is to destroy the growth of shoots put forth prior to the middle of June. This injury, continued year after year, results in bunches of dead stubs, a clump of which is shown in the colored plate (II.), drawn from a specimen cut by me from a tree in one of the parks in Decatur. The short blackened stub to the right shows the work of the larvæ two years ago; the longer one to the right of it, with the two blackened laterals, shows the work last year; while the green and brown shoots show the effect on the twigs the present season. The single small twig at the extreme right, which sprang out from the base of a larger one already affected, was the only one of the cluster that had escaped destruction, it having been put forth after the beetles had disappeared. By another year this whole group of twigs would have become hollow blackened stubs. Fresh growths being attacked and destroyed in the same manner, the cluster of dead stubs is increased year after year. In such a case as that of the uninjured twig at the extreme right in the colored plate, the larva would continue its work another spring and, passing below the juncture, finish the destruction of the group.

HABITS OF THE ADULT INSECT.

Two very striking peculiarities were observed by both Mr. Titus and myself. In the twenty-five years that I have been studying the habits of insects, I do not recall an instance of such seemingly utter disregard for the perpetuation of the species as is exhibited by these beetles. The vicious assaults which they make on each other, regardless of sex, are paralleled only among the *Mantidæ* and some species of spiders. While I

did not notice any conflicts in the open, we both experienced the utmost difficulty in keeping the adults in sufficiently close quarters to enable us to study their actions. If a male and female were confined at all closely, they would instantly attack each other with such ferocity that within a few moments they would be rolling helplessly about among fragments of legs and antennæ, only the basal portions of these remaining attached to their bodies. It was found wholly impossible to transport living individuals without giving them ample quarters, and I was finally forced to give each a box or vial to itself.

The other peculiarity referred to is a lack or insufficiency of the dispersal instinct when the beetles become excessively abundant in a locality. Though no trace of them was found in some parts of the city of Decatur, in other parts they were so abundant that the young growth of the elm did not afford them sufficient material in which to mature more than a small percentage of their larvæ, only one of which can develop in a single twig, but instead of hunting for other trees where suitable conditions existed, the females girdled the twigs and deposited the egg where this had been done, not only once, but time and time again, before. I have found twigs in which there had been as many as eight separate ovipositions, with the usual number of girdlings in each case.

The upper figure in the colored plate affords a very good illustration of a multiplicity of ovipositions, as also one of the twigs in the cluster below. We have here, consequently, what might almost be termed insect infanticide on a stupendous scale. But the full extent of this wholesale murder does not appear in the illustrations. In all examinations of the amputated portions of the twigs made by Mr. Titus, he found none which contained eggs or larvæ, and this was true of my own observations, made during the early part of the egg-laying season. Late in May, however, I began to find sections of amputated twigs on the ground underneath the trees, which showed plainly that this amputation was not the result of a first visit of a female intent on oviposition. Ordinarily, the tip of the twig is severed far

enough back to include from two to four or five leaves, and this amputated portion is free from egg or larva. But I now began to find, scattered under the infested trees, pieces of twigs which had been cut off at both ends, and those freshly dropped contained in most cases either an egg or a newly hatched larva, while in the older, withered ones there was more often a very young larva, dead. As the season of oviposition advanced, these secondary amputations, repeated perhaps five or six times on the same twig, became more numerous, and an examination of the trees disclosed the fact that nearly every twig contained at least one egg or larva, and that some of them contained several. For those females that had yet to oviposit, there were no twigs not preoccupied, and fully five per cent. of the amputated pieces on the ground contained a larva or an egg. It became clear that the mortality resulting from this repeated oviposition and amputation was greater than that from all other causes combined.

The beetles appear to feed but little, and then only on the leaf veins, as shown in Fig. 5, Plate I., and at the extreme right of the colored plate. Neither Mr. Titus nor myself found them feeding on any other part of the leaf, or any indication of their having done so, even when confined in breeding-cages.

FOOD PLANTS.

It would seem from the information thus far obtained, that this species confines itself strictly to the American elm. While the beetles will, if confined on other plants exclusively, feed sparingly on the leaves, they will not oviposit in the twigs, but if removed and placed on elm, they will proceed to deposit their eggs. Adults of both sexes confined on raspberry May 20, were all dead by May 29, having in the mean time shown no inclination whatever to oviposit, though the sexes were observed in the act of pairing. The same was true of those confined on *Cornus;* but when removed, these females oviposited in elm. These statements are taken from Mr. Titus's notes, and my own experiments simply duplicated these results. Though I found *Oberea* larvæ in other kinds of trees in the parks at Decatur, I am confident that these belonged to another species, probably *Oberea*

tripunctata, which was also reared from elm-trees infested by *ulmicola*. No experiments were tried with other species of elm.

NATURAL ENEMIES.

As may be seen from the foregoing, this species is its own greatest enemy. No egg parasites have been found, though such may confidently be looked for in the future. That the eggs are to some extent destroyed by birds, appears probable, though none were observed in the act. Nuthatches were present in the trees, both in those infested and in those free from the pest, and the frequent occurrence of twigs with the bark pushed upward and outward at the point where the egg is usually placed, as is shown in Plate II., upper figure, suggests clearly that some feathered enemy had pushed its beak beneath. As this lifting of the bark was noticed only on the side of the longitudinal slit where the egg is usually placed, it is fair to presume that either the egg or young larva had been removed.

GENERAL EFFECT ON ELM-TREES.

The production of bunches of short twigs which are annually killed and replaced by others, these suffering in turn in the same manner, has been already described, and the inevitable effect on the general appearance of the trees will be clear to any one at all familiar with the growth of young elms. They gradually assume a scraggy, stunted, and misshapen appearance, with the foliage inclined to grow in tufts about the larger limbs, the latter throwing up an unusually large number of water-shoots, which, being killed down each year, add to the unsightly appearance of the tree. The limbs may increase in size but not in length, as each year's growth is killed back the same year. Sometimes the larvæ working in spring pass beyond into lateral twigs which had escaped attack and cause their death. I have found lateral twigs and fresh growths withering and dying from this cause as late as the latter part of May. Larger trees do not show the injury as much as smaller ones, but even the former will lack the broad, wide-spreading growth so much admired in the elm. Not all trees standing in

close proximity are affected alike. Some will be girdled comparatively little, while others, perhaps but a few rods away, will suffer a most serious pruning. It would seem as though the beetles were disinclined to forsake the trees from which they had themselves emerged,—a supposition strongly supported by their extremely local distribution.

DISCOVERY OF THE SPECIES.

The attention of the custodian of the Decatur city park was first attracted to the insect by the enormous dropping of the leaves during late May and June, this increasing the labor required to keep the grounds in proper condition. The facts were first reported to the State Entomologist in October, 1901, at which time it was said that the injury had been noticed for some two or three years preceding, becoming more serious each year. The tips of the twigs, with from three to six leaves attached, appeared to have been cut squarely off in a way to suggest the work of an insect, but of the author of the injury itself nothing had then been learned. May 23, 1902, Mr. Titus was sent to Decatur by Professor Forbes to learn the cause of the injury, and it was during this visit that he first secured material for his studies of the habits and life history of the species. This was supplemented by further accessions from the trees during the remainder of the season, and by carrying the females with him, in his travels about the state, Mr. Titus was enabled to secure the facts here given relative to oviposition and to the actions of the very young larva. Other data were obtained by carrying the insect through the year in the insectary. The writer took up the investigation in the spring of 1903, and was able to add somewhat to the results of the careful work of Mr. Titus, as well as to clear up some points on which the latter had not been able to secure conclusive evidence.

EXPLANATION OF PLATES.

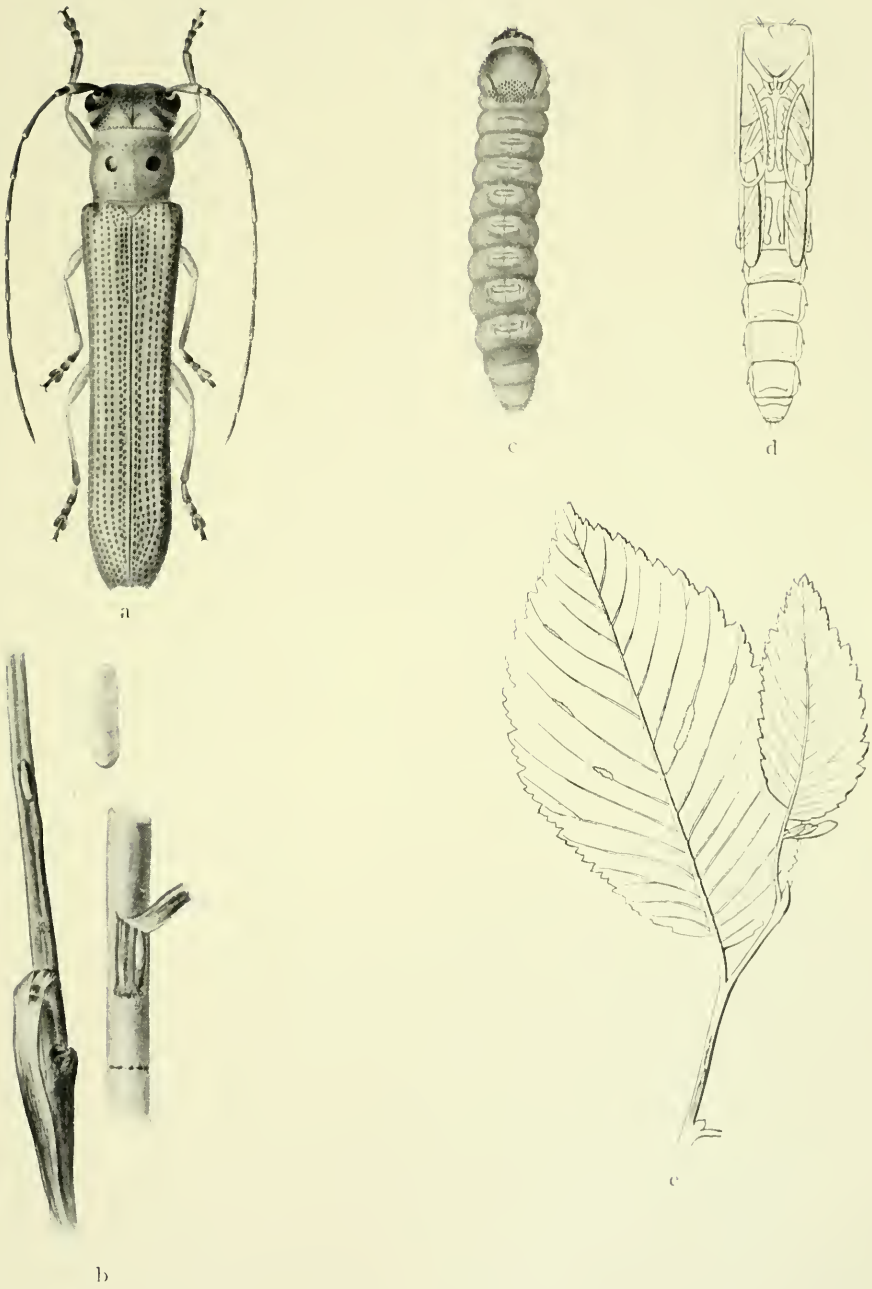
PLATE I.

The Elm Twig-girdler, *Oberea ulmicola* Chittenden: a, adult beetle; b, egg, enlarged and in position under bark of twig; c, larva, d, pupa, e, showing leaf-veins eaten out by beetle in feeding.

PLATE II.

Elm Twig-girdler, *Oberea ulmicola* Chittenden; a, illustrating girdling of twigs by adult and the general effect on the young twigs, the original having been cut from an elm-tree in a city park in Decatur, Ill.; adult shown engaged in feeding on leaf at right; b, a much girdled twig illustrating the effect of birds in searching for eggs or young larvæ.

I.



Injuries caused by Elm Twig-girdler (Oberea ulmicola Chittenden).

ARTICLE II.—*Studies of the Habits and Development of Neocerata rhodophaga Coquillett.* BY F. M. WEBSTER.

About the year 1897, in the vicinity of Chicago, Illinois, certain varieties of roses grown under glass, notably the Meteor, were attacked by great numbers of minute cecidomyian larvæ which destroyed the terminal leaf and blossom buds. In the greenhouses of one extensive rose-grower, the injury was so severe as to render the production of the Meteor unprofitable, and he stopped growing it for a time, until the pest seemed to have disappeared. Strangely enough, another grower, whose houses were separated from those of the first only by a narrow alley, did not at that time suffer at all from the ravages of the insect, but continued to grow the Meteor in his rose-houses without difficulty until sometime after, when he, too, began to experience severe losses on account of its depredations. The species was not definitely determined at that time, and it is impossible in the light of later investigations to say with certainty whether or not more than one was engaged in these attacks. Since then, however, a number of extensive rose-growers about Chicago have been obliged to abandon the growing of this particular variety of rose on account of its extreme liability to attack from these larvæ.

In 1900, Mr. D. W. Coquillett published a paper* reporting similar injuries to roses grown under glass in New Jersey in 1886 and 1889; New York in 1890; Washington, D. C., in 1891, 1894, and 1896; Boston in 1894; and Chicago, as has been stated, in 1897. In this paper, Mr. Coquillett describes a new species, *Diplosis rosivora*, and a new genus and species, *Neocerata rhodophaga*, both of which were reared from larvæ attacking roses in this manner in Washington, D. C. The author says that the larvæ of the former species—those of the latter being unknown to him—"are of a white color when young, but become

*Bull. 22, N. S., Div. Ent., U. S. Dept. Agr., pp. 44-48.

orange-red in the latter part of their periods". Elsewhere in his paper he tells us that these larvæ are entirely devoid of the the so-called "breast-bone", and in still another place expresses the suspicion that the species was originally a native of some tropical region, as they were not known to attack roses in the open air. Summarizing this information, then, we have a peculiar injury to roses, especially to the Meteor, a variety originating in Europe, occurring in widely different localities, due to two species of insects, working to all appearances precisely alike, and reared from infested plants growing in Washington. Apparently the same species was sent to the U. S. Department of Agriculture from Cleveland, Ohio, in 1903.

On May 16, 1903, a firm located in the vicinity of Chicago, engaged in growing roses extensively under glass, advised the State Entomologist of serious trouble among their Meteors, evidently due to a minute white worm which attacked the buds and destroyed them. Early in June, Mr. C. A. Hart, being in that vicinity, visited the premises by Dr. Forbes's direction, and brought some of the affected buds to the office. The larvæ found in them were very small, white, except those seemingly full grown which were tinged with orange, and the so-called "breast-bone" was clearly present.

The matter was now placed in my hands for investigation, and on June 11, acting under instructions, I visited the rose-houses containing the injured plants. Larvæ were found in the young rosebuds of both leaf and blossom, but more abundantly in the latter, and also eggs, which, from their position in these buds, indicated that they were those of the same species as the larvæ. Several very minute female midge-like flies were also taken, seemingly in the act of ovipositing in the blossom buds.

SPECIES DIFFERS FROM THOSE PREVIOUSLY DESCRIBED.

The larvæ found in the rosebuds did not agree with those described by Mr. Coquillett, but, like those brought home by Mr. Hart, possessed the "breast-bone", and the older individuals were not an orange-red color, but slightly tinged with orange with-

out any clearly defined pattern to the coloration. The adult flies afterwards reared from these larvæ did not entirely agree with either of the species described by Mr. Coquillett, but proved to be the same as those observed in the act of ovipositing in the buds. Moreover, from larvæ inhabiting the buds at this time I reared adults which, ovipositing in other buds on plants provided them, gave me eggs like those previously observed, as well as larvæ, pupæ, and adults, afterwards reared from these eggs. Clearly, I was dealing with a species whose larvæ inhabited rosebuds in the same manner as those described from Washington. Specimens have since been submitted to the noted British dipterologist, Mr. F. V. Theobald, who reported upon them as follows:

"I have made a number of careful preparations of the rose cecidomyid. The female you sent previously had the antennæ broken. But for the antennæ, they exactly answer to *Cecidomyia rosarum* Hardy. I feel quite sure they are all Coquillett's *Neocerata rhodophaga* (Bull. 22, N. S., Div. Ent., U.S. Dept. Agr., p. 47. 1900). The males are all 9-jointed in regard to the antennæ, and exactly answer Coquillett's description. I mounted some twenty females, and found the antennal joints vary from 9 to 11, so the character of his genus (which is certainly a good one) in regard to antennal joints must be modified. There is no doubt that antennal joints vary in cecidomyids, especially in the female sex. In one I found an evidence of transition between 10 and 11 joints. All the males, some fifteen, had the same genitalia and 9-jointed antennæ. The globular second joint is very characteristic. Note also the marked lepidopterous scale in this species."

While the normal antenna of the female is shown in Plate III, i, and is certainly 10-jointed, with an occasional indication of 11 joints, as stated by Mr. Theobald, the terminal joint being prolonged and constricted but without distinct articulation, yet there is a wider variation than was observed by him. In one case a female was found with a 6-jointed antenna on one side, joints 3 and 4 being fused, with the terminal joint fully twice the ordi-

nary length, while the other antenna consisted of 9 joints, the terminal one seeming to consist of two fused together. Another female had 9-jointed antennæ, but again the terminal joint was fully twice the normal length, with the same appearance of two joints being fused as is exhibited where there are 10, and a constriction as if indicating an 11th joint, while still another female had 9-jointed antennæ, with an indication of a tenth. The males all have 9-jointed antennæ. It will thus be observed that the female does not agree with Mr. Coquillett's description of this species. Hardy described *Dichelomyia* (*Cecidomyia*) *rosarum* as having 14-jointed antennæ, so our species does not fit his description, though, as stated by Mr. Theobald, aside from the number of antennal joints there is no perceivable difference between them. We have shown that the number of joints in the female antennæ of the American species is too variable to be considered a specific character. Are not those of Hardy's species equally variable, and did he not describe a variation instead of the normal? How far can the number of antennal joints be relied upon in separating the species of *Cecidomyiidæ*? These are questions that I am unable to answer, but they have a decidedly important relation to the solution of the problem of the specific identity of the insect under consideration.

The larvæ from which all my material was reared, closely correspond with the description given by Hardy, but unfortunately he could not say whether it was his *C. rosarum* or *C. rhodophila* that developed from them.

HABITS OF THE BRITISH SPECIES.

The habits of *Dichelomyia rosarum* are given in "Die Rosenschädlinge," p. 272, by Friedrich Richter v. Binnenthal; and by Rübsaamen, in "Biologisches Centralblatt," Vol. XIX., Nos. 16, 17, and 18. Mr. Theobald informs me that he has found it attacking roses in England, both in rose-houses and in the open. In the open, it attacks the dogrose, *Rosa canina* Linn., the commonest rose in Britain, which grows rapidly and luxuriantly in hedges, thickets, and various dry places in every part of the country. "The gall is formed by the edges of the leaflet

rising above the midrib until they approximate and a thin-walled hollow pod is formed. The galls may be sought for during the months from June to October. The larvæ pupate in the ground, the imagines emerging in about six days after pupation."* The galls on the leaves are certainly more conspicuous than are the effects of the American species in this country, in rose-houses. The species winters in the pupal stage.

HABITS OF THE AMERICAN SPECIES.

I have never seen the larvæ attacking the native wild roses, even about Chicago, though, in the near vicinity of infested rose-houses, I have found them in buds of a variety known as the Bride, growing in the open air. The manner of hibernation in our species is not well understood, but in the rose-houses there is no injury done by the larvæ from late October until late the following May. A thorough inspection of large rose-houses about Chicago, November 18–20, did not reveal a single larva or adult, even where serious damage had been wrought a few months before, and an inspection made on January 29, 1904, also failed to reveal their presence.

In the rose-houses, the larvæ attack the Meteor, Wooton, Bride, Madame Chatenay, La France, Ivory, and Golden Gate, but are far more fatal to the first than to any other variety. The insect first appears in such rose-houses as are old and more or less open on account of cracks and crevices, or else in such as are new and tight, requiring much ventilation. In the case previously referred to, where only an alley separated infested from uninfested premises, the uninfested houses were given the least possible ventilation consistent with the growth of the roses, while those infested were more generally ventilated. Later on, these conditions were reversed, and the situation as to insects changed also, the premises that had before escaped being now overrun.

An experienced foreman in the employ of a firm of extensive rose-growers whose premises were infested with this midge, informed me that the insect first attracted his attention by at-

*"British Vegetable Galls," by Edward T. Connold, p. 206, Plate 87.

tacking those buds that were highest up and nearest to the glass, and that the larvæ were only to be found in such buds as were in close proximity to the glass, those situated lower down not being at all affected, thus indicating that one rose-house may become infested from another by adults, and not necessarily from the introduction of infested plants. From the fact that there are but few larvæ present up to the month of May, but that they increase in number during the summer and altogether disappear in late October, it would seem that they follow very closely the habits of the British species.

The eggs are deposited either in the unfolding leaf buds or under the sepals of the blossom buds, the latter position seemingly being preferred by the females where there is an opportunity for selection. In case the former is chosen, the eggs are deftly inserted in the conduplicated leaves between what would, later on, constitute the upper surfaces of the two halves of the unfolded leaf. The maggots appear to fasten the edges together with some viscous matter, thus forming a sort of pod within which they attain their larval growth. If there are few larvæ, their effect is to cause more or less prominent swellings on what would later become the lower surface of the leaf; if there are many larvæ in the leaf, it simply becomes distorted and discolored and dies, leaving the affected parts as illustrated in Plate III,a. In case of blossom buds, the effort of the female seems to be to place her eggs as far under and near the base of the sepal as possible, but there does not appear to be any regularity either in their exact position or numbers. Occasionally they will be found stuck in the sutures separating the sepals. The ovipositor of the female is capable of great extension, and I have observed it to be curved, coiled, and twisted in her efforts to push it under the closely adhering sepal of a very young bud. Frequently, after this has been accomplished she is unable to extricate it, and dies attached to the bud. In one case I found two females on a single bud, they having apparently perished in this manner. Nevertheless, the females seem to be strikingly attached to their labor of ovipositing, as, in a propagating

house where there were thousands of young plants with but few blossom buds, if they were driven from one of these they would fly but a few inches away and soon return. They are exceedingly minute, and obscure while on the wing, having much the appearance of floating particles of dust.

While the larvæ are at first usually well covered by the, sepals and folded leaves, if excessively abundant they will, later swarm out and over the outer surface, especially of the blossom buds, finally leaving them in the condition indicated in the plate.

DESCRIPTION.

Egg (Pl. III., b).—Length, 0.32 mm.; width, 0.075 mm. Smooth, orange color with tinge of yellow, elongated ovoid, with one end but slightly obtuse.

When placed under the sepals, the eggs are often slightly bent or otherwise distorted, but when deposited on the surface or in the folded leaves, this does not occur. They have a vague resemblance to the hair-glands of the buds, and might be mistaken for these by the careless observer. The egg period is two days.

Larva (Pl. III., c, d).—The newly hatched larva is but little larger than the egg from which it emerged, and much the same color. Later it becomes nearly white, but when approaching maturity it takes on a reddish tinge, without definite pattern in its coloration, except that the lateral margins remain white. The amount of color varies with individuals, but none are wholly orange. The length of a fully grown larva is 1.8 mm.; width, 0.45 mm.; widest at middle, obtuse and tuberculated on the posterior segment, tubercles with minute apical spine, surface finely granulated, lateral margins distinctly compressed, attenuated anteriorly, breast-bone distinct, a conspicuous black spot on upper side and showing through to the under side indistinctly, just in front of breast-bone. Antennæ short, not extending beyond the body.

When fully grown the larvæ crawl out and drop to the ground, and I have observed as many as twenty-five in a single

blossom bud. They are very tenacious of life. Those Mr. Hart secured some days after removal from the buds and placed in 80 per cent. alcohol at 11:25 a.m., were still active at 2:40 p. m., and lived for some time in the 95 per cent. alcohol in which I then submerged them, but at 3:50 p. m. seemed to be dead. Infested rose plants were fumigated with hydrocyanic acid gas, in one case one tenth, and in another fifteen hundredths of a gram of potassium cyanide being used to each cubic foot of space. The plants were subjected to the gas for fifteen minutes in both cases, with the result that only the larvæ that were exposed were killed, while such as were protected by the sepals were not affected. The same treatment killed flies (in from twenty to thirty seconds), plant-lice, and beetles. On descending into the ground the larva constructs an almost transparent cocoon—presumably the product of exudation—sufficiently viscid to stick to surrounding particles of sand or dirt, and becoming sufficiently tough to retain its contents. Within this the larva remains two days, some of the time in a curved position, when it passes into the pupa state. The larval period, including two days in the cocoon, is seven days. That moisture has little influence on the development of the insect is shown by the fact that pupation in this case was continued in sand thoroughly saturated with water.

Pupa (Plate III., e, f).—Length, 1.6 mm.; width, 0.53, mm. Color, at first as in the full grown larva, later the eyes are red and the general color of the body more reddish-yellow, but at the time of emerging from the cocoon the eyes are black, the antennæ and legs nearly black, and the head and prothorax dusky. On the dorsal abdominal area is a median red space, widest at base, diminishing to the sixth segment. On all of the segments except the first is a transverse spinulose ridge near the anterior dorsal margin, less marked on the second segment and increasing in size to the eighth, which is sculptured somewhat as in the larva. Ventral surface without spinulose ridges. Anal segment much smaller than seventh, which is slightly smaller than sixth. Bases of antennæ produced, with

the usual pair of bristles just behind them, while the two large, pointed respiratory tubes protrude through the cocoon, as though utilized by the pupa in making its way forth. Pupal period, six days.

On making its way from the cocoon to the surface of the ground, the pupa travels by the aid of the spinulose ridges on the back. One under observation, which had pupated in water in a watch-glass, crawled to the rim and traveled three times around the edge entirely on its back; and another, which emerged under a bell-glass, traveled for a distance of six inches, also on its back, over the moistened inner surface of the glass.

Rdult (Pl. III., g, h).—"Antennæ in both sexes slightly shorter than the head and thorax taken together, nine-jointed; joint 1 obconical, 2 globular, wider than any of the others; joints 3 to 8 only slightly longer than wide, subsessile, the hairs very sparse, not arranged in whorls; joint 9 almost twice as long as 8, slightly constricted near the middle. Wings hyaline, bare except along the hind margin near the base and on the veins, which are sparsely bristly, rather densely bristly along the first half of the costa, interspersed with flattened bristles; the first vein lies very close to the costa, which it joins slightly before the middle of the wing; third vein evenly arcuate, joining the costa far before the extreme apex of the wing, this distance almost equaling one-half of the greatest width of the wing, the extreme base of this vein, where it joins the first vein, very indistinct; fifth vein indistinct toward its apex, forked at its last fourth, the anterior fork reaching the hind margin a short distance basally of the tip of the third vein. First tarsal joint less than one-half as long as the second, claws of tarsi simple. Color of alcoholic specimens yellow, the head and thorax tinged with brown. Length, 1 to 1.25 mm." (Coquillett.*)

NATIVITY OF THE INSECT.

In the light of the foregoing it will be seen that our rose-attacking insect is not a native species, else it would certainly

*Bull. 22, N. S., Div. Ent., U. S. Dept. Agr., p. 47.

have attracted attention by its appearance in roses in the open air, and its gradual occurrence farther and farther inland does not imply an American origin.

It affects the most seriously a species of rose that requires a very warm, yet ventilated environment, and which, indeed, is one of the most difficult varieties to grow successfully in this country, besides being of European origin. In England and Europe there is also a rose-attacking insect which can only be separated anatomically from our species by the number of antennal joints, a character known to be somewhat variable. The habits of the two are very much alike, except that in Britain the larvæ affect the leaf buds and not the blossom buds, both in the rose-houses and in the open air. Our species attacks roses only in rose-houses, largely confining its ravages to the blossom buds, but when attacking the leaf buds affects them as does the English species. In Britain, and in the open air, the wild, or dogrose, though it grows rapidly, can not certainly make as rapid growth as does the Meteor in our rose-houses, where all the ingenuity of the grower is centered on producing the most rapid and vigorous growth possible. It is doubtful if the American species could, under these conditions, develop in any considerable numbers in the leaf buds, as the growth of the buds is so accelerated by artificial conditions that there is not time for the larvæ to develop within them before they become too much expanded and too tough to admit of the larvæ affecting them. The blossom bud, being of a slower development, affords a longer time for the larvæ to mature, and, besides, presents food of a different character from that of a leaf bud.

To sum up the whole discussion, then, it is not now possible to regard our American species as the same as that occurring in England and Europe, known as *Dichelomyia rosarum* Hardy, but that it is closely allied to that species can not be doubted. We must wait for future studies to show us whether our Americanized form has sufficiently developed to admit of its being separated as a new genus and species.

I have held to Mr. Coquillett's specific name because it is

very convenient whereby to designate our American insect, and time, which sooner or later will settle these problems, will put the question to rest, perhaps by proving that his new genus and species is entirely distinct. At present, we know too little of these insects to go beyond this.

EXPLANATION OF PLATE.

Plate III.

The Rose Midge, *Neocerata rhodophaga* Coquillett: a, illustrating effect of larvæ on blossom and leaf buds; b, egg; c, newly hatched larva; d, fully grown larva; e, immature pupa in cocoon, dorsal view; f, immature pupa in cocoon, lateral view; g, adult male; h, adult female; i, normal antenna of female.

Figures a, b, c, and d, Plate I., and b, c, d, e, f, g, h, and i, Plate III., all greatly enlarged; Figure e, Plate I., and Plate II., all about natural size; Figure a, Plate III., reduced. All figures drawn from life by Miss Charlotte M. Pinkerton, under author's supervision.

Articles I. and II. issued Feb. 26, 1904.

III.

The Rose Midge (Neocerata rhodophaga Coquillett) and injured plant.

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A REVIEW OF THE SUNFISHES OF THE CURRENT GENERA APOMOTIS, LEPOMIS, AND EUPOMOTIS, WITH PARTICULAR REFERENCE TO THE SPECIES FOUND IN ILLINOIS.

BY

R. E. RICHARDSON, A.M.

ARTICLE III.—*A Review of the Sunfishes of the current Genera Apomotis, Lepomis, and Eupomotis, with particular Reference to the Species found in Illinois.* BY R. E. RICHARDSON.

During the progress of studies on material from the large collection of Illinois sunfishes belonging to the Illinois State Laboratory of Natural History, a striking and, as it appeared later, fundamental difference in form was observed between the lower pharyngeals of specimens of *Lepomis pallidus* (Mitch-

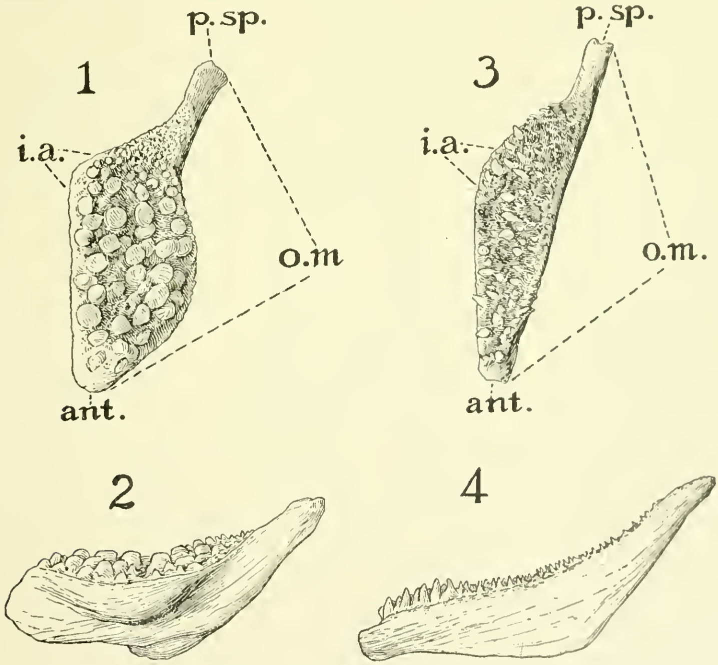

Fig. 1, *Eupomotis gibbosus*, lower left pharyngeal, from above; 2, side view; 3, same of *Lepomis pallidus*, from above; 4, side view.

Ant., anterior apex; *p. sp.*, posterior spur; *o. m.*, outer margin; *i. a.*, inner angle.

ill) and *Eupomotis gibbosus* (Linnæus). These bones in the first species were found to be comparatively light, flattened dorso-ventrally, and always narrow, the width in the length of

the toothed portion of the bone ranging from 2.9 to 3.4 and averaging more than 3 in twenty measured specimens whose length ranged from $2\frac{3}{4}$ to 6 inches. The inner angle (*i. a.*) is quite obtuse, 120° to 140°, and the outer margin (*o. m.*) is straight or slightly inbent from the tip of the posterior spur (*p. sp.*) to the anterior extremity (*ant.*) of the bone. The lower pharyngeals of *Eupomotis gibbosus* are deep and broad, with inferior and lateral prominences, never being flattened or hollowed out underneath as in *L. pallidus.* Measurements made on twenty specimens, from $2\frac{1}{2}$ to 6 inches in length, show a variation of only 1.9 to 2.5 (average 2.17) in the ratio of width to length of the toothed portion, and a range of 95° to 111° in the inner angle. The outer margin of the pharyngeal in this species presents a double curve, with a moderate sinus situated posteriorly, immediately in front of the spur, and a more or less decided anterior arcuation, margining a lateral ledge-like prominence. The spur is directed more or less definitely outward, rather than backward as in *L. pallidus.* The differences between the teeth of these two species were found to be as hitherto described, those of *E. gibbosus* being short and heavy and either very blunt or entirely paved, while those of *L. pallidus* are long and comparatively slender, with more or less acuminate tips.

An examination of the pharyngeal bones and their teeth from specimens of *E. heros* and *E. holbrooki** disclosed complete conformity in those species to the type of bone and tooth found in *E. gibbosus.* The pharyngeals of *E. euryorus* McKay proved, however, to be of the pattern found in *L pallidus.* The pharyngeals of *Apomotis cyanellus, ischyrus,* and *symmetricus,* and of *L. miniatus, auritus, megalotis, occidentalis,*† *humilis,* and *haplognathus* were also found to differ in no essential respect from these bones as described for *L. pallidus.* The lower pharyngeal teeth of *A. cyanellus, ischyrus,* and *symmetricus,* and of *L. miniatus* and *E. euryorus* appear as a rule to be somewhat less

*Through the courtesy of Dr. S. E. Meek, of the Field Columbian Museum, we have been permitted to examine specimens of this and other species not found in the waters of Illinois.

†*L. occidentalis*, Meek, Field Col. Mus., Zool. Ser., Vol. II., No. 6, p. 118.

slender and acutely pointed than the teeth of the remaining species of the genus *Lepomis*, but this distinction is recognizable only with difficulty, and is scarcely to be regarded as of even subgeneric value. In the case of *L. pallidus* and *E. gibbosus*, and in other species when possible, care was taken to examine the pharyngeals of a considerable number of young specimens, and no difficulty was in any case experienced in making out the distinctive form of the pharyngeal in each species, the best idea of which is obtained from the accompanying figures. While the ratio of width to length of the toothed portion of the bone becomes greater in the young of *Eupomotis*, it was in no case found to equal the ratio obtained for the species of *Apomotis* and *Lepomis*.

Species of which I have yet had no opportunity to examine specimens are *A. phenax* and *punctatus*, *L. macrochirus*, and *E. pallidus*. Of the first two there can scarcely be any doubt concerning the generic affinities, the first species being possibly identical with *A. ischyrus* (Jordan & Nelson). Of *L. macrochirus* little is known. In view of the palatine teeth, long gill-rakers, and dusky color at back of dorsal and anal in *E. pallidus* (Agassiz), I have, with Boulenger, regarded that species as identical with *L. pallidus* (Mitchill), and have taken no account of it in the present characterization of the genus *Eupomotis*. Consequent on the removal of this species and *E. euryorus* McKay to the genus *Lepomis*, and apparently in no other way, does it become possible to establish the genus *Eupomotis* beyond question on characters that have constant value.

Lepomis Rafinesque.

Lower pharyngeals narrow and comparatively weak, flattened or hollowed out underneath; width in length of toothed portion about 3 in adult specimens; inner angle, 120° to 140°; outer margin straight or slightly inbent from tip of posterior spur to anterior extremity of bone; pharyngeal teeth always long and slender and more or less acuminate. Brilliant colors

on posterior margin of opercular flap, if present, always blending with the adjacent paler or darker color, and not forming a definitely localized spot as in *Eupomotis*.

A somewhat heterogeneous group, represented in this state by eight species, the genus as here understood including *Apomotis* and *Lepomis* of recent authors. The form of the body is variously elongate, elliptical, or short and deep. Most of the species are inclined to be rather robust, while others are thin and compressed. Mouth various, usually rather large; supplemental maxillary bone well developed in some species, rudimentary or wanting in others, its development greatest in those species which have the mouth largest; teeth on palatines in most species. Operculum ending behind in a convex bony or osseo-membranous process or flap, its development much greater in some species than in others and subject to variation with age; the flap proper well differentiated (or not) from a fleshy or membranous margin partly or wholly of paler color than the opercular spot. Gill-rakers well developed (long, stiff, and rough) to rather slender, or very soft and weak. Pectorals nearly always considerably shorter than head, but about equaling it in some species (*megalotis*, *humilis*, *pallidus*); dorsal spines usually low, but scarcely lower in some species than in *Eupomotis*.

KEY TO THE SPECIES OF THE GENUS LEPOMIS FOUND IN ILLINOIS.

A. Operculum more or less stiffened posteriorly, its osseous portion always distinctly differentiated from a posterior fleshy or membranous margin, which is about equally broad above, behind, and below, and partly or wholly of paler color than the osseous portion, to which the black of the opercular spot is entirely or for the most part confined. A well-developed supplemental maxillary bone.

b. Scales moderate or small, 42 to 50 in lateral line; operculum produced backward and rather sharply rounded behind, triangular.

c. Soft dorsal dusky, with a more or less distinct blotch of darker color near base of last rays; dark coloration on scales regular, with no appearance of mottling due to darker color on scattered groups of scales.

d. Body oblong, depth 2.2 to 2.5 in length; profile long and straight; margin of ear-flap coppery to purplish . . . . *cyanellus.*

dd. Body short and deep, depth 1.8 to 2 in length; profile steep, convex in front of dorsal, and with angle at nape prominent; margin of ear-flap pale blue to pinkish. . . . . *ischyrus.*

cc. Soft dorsal tessellated with darker but without large black blotch at base of last rays; dark coloration more intense on scattered groups of scales, resulting in a mottled appearance much as in *E. gibbosus*; in life, some red or coppery on ear-flap behind. *euryorus.*

bb Scales large, 35 to 41 in lateral line; operculum not prolonged much backward, but more or less broadly rounded behind, not triangular.

e. Flexible margin of operculum narrow, its width $\frac{1}{4}$ to $\frac{1}{3}$ the length of the black opercular spot, which is mostly confined to the bony portion; body green, barred with darker; small coffee-colored specks on body and fins. *symmetricus.*

ee. Flexible margin of operculum broad, $\frac{1}{2}$ to as wide as the black or dark green spot on osseous portion, and mostly of the same dark color; body dusky olive, with rows of red or orange spots on sides. *miniatus.*

AA. Operculum thin and flexible behind, its thin membranous margin much produced and broadened posteriorly, with a rather wide edging of pinkish to crimson almost surrounding the black of the opercular spot, which is mostly confined to the membranous extension, barely tipping the osseous portion of the flap. No supplemental max-

illary bone. Color olive, with orange spots; body rather elongate; size small, not exceeding $3\frac{1}{2}$ inches. *humilis.*

AAA. Operculum not composed of well differentiated osseous and membranous portions, the bone becoming gradually thinner posteriorly and terminating in a flexible osseo-membranous flap, which is usually considerably produced in adults, sometimes exceedingly so, and is entirely black or with only a very narrow edging of pale. Supplemental maxillary bone very rudimentary or entirely wanting.

f. Dorsal spines low, the longest but slightly more than snout; gill-rakers very short and weak; color olive, with blue or orange spots and wavy vertical streaks of emerald; no black blotch on dorsal or anal behind. .... *megalotis.*

ff. Dorsal spines higher, the longest usually greater than snout and eye; gill-rakers rather long and slender; color olive, with purplish lustre, usually rather dark; dorsal and anal with black blotch at base of last rays. .... *pallidus.*

Lepomis cyanellus Rafinesque.

Apomotis cyanellus, Jordan & Evermann, Bull. U. S. Nat. Mus., No. 47, p. 996.

Distributed throughout the state, being the most abundant sunfish in the smaller prairie streams and pools of central Illinois.

Lepomis ischyrus (Jordan & Nelson).

Apomotis ischyrus, Jordan & Evermann, Bull. U. S. Nat. Mus., No. 47, p. 997.

Type, in possession of the Illinois State Laboratory of Natural History, obtained from the Illinois River in 1877. Not again taken until 1899, when two excellent adult specimens were obtained from the Illinois River at Meredosia.

Lepomis euryorus (McKay).

Eupomotis euryorus, Jordan & Evermann, Bull. U. S. Nat. Mus., No. 47, p. 1008.

Form strongly suggestive of *Eupomotis gibbosus*, but the

body robust and rather more elongate than in that species; dorsal outline more arched than ventral; depth 2 to 2.3, head 2.6 to 2.9 in length. Mouth large, oblique, maxillary reaching considerably past front of orbit, 2.6 to 2.9 in head; jaws about equal; supplemental maxillary well developed; teeth present on vomers and palatines; lower pharyngeals narrow, the teeth rather bluntly pointed; eye small, 3.8 to 4.3 in head; opercle produced backward and rather sharply rounded behind, triangular; gill-rakers well developed, rather stiff and rough. Dorsal X, 11 or 12, the spines low, but slightly longer than from snout to eye in young specimens, 2.2 to 2.7 in head; anal III, 9 or 10; pectorals short, 1.3 to 1.4 in head; ventrals reaching a little past vent. Scales 6 or 7, 43–45, 14 or 15, those on cheeks small, in 6 to 8 rows. Color in life not very well known; in spirits dusky olive, mottled with darker, the general appearance very much as in *E. gibbosus*; fin-membranes dusky, with darker tessellations behind on soft dorsal and anal and near base of caudal; opercular spot black, the margin paler, with some red or coppery behind in life.

Known in this state from two young specimens, 2 and 3½ inches in length respectively, taken in Crooked Creek, near La Harpe, Illinois, in May, 1900. These specimens form the basis of the present description.

Lepomis symmetricus Forbes.

Apomotis symmetricus, Jordan & Evermann, Bull. U. S. Nat. Mus., No. 47, p. 998.

Not taken in Illinois since 1883, when it was described by Professor Forbes from specimens taken in the Illinois River at Pekin. Found only sparingly, chiefly in the southern portion of the state, especially the Wabash valley.

It has not been observed that the pharyngeals of this fish suggest affinities with the genus *Eupomotis* as hitherto supposed.

Lepomis miniatus Jordan.

Lepomis miniatus, Jordan & Evermann, Bull. U. S. Nat. Mus., No. 47, p. 1002.
Lepomis garmani, Forbes, Bull. Ill. State Lab. Nat. Hist., Vol. II., Art. II., p. 135.—Jordan & Evermann, Bull. U. S. Nat. Mus., No. 47, p. 1002.

Specimens which I now refer to this species were de-

scribed by Professor Forbes in 1885 from the Wabash and Little Fox rivers in southern Illinois, under the name of *L. garmani*, but no examples have since been taken in that part of the state. The types of *L. garmani* Forbes are thin and rather deeply angled at the nape, with pectorals comparatively long, 1.2 to 1.4 in head, and dorsal spines rather high, 1.9 to 2.2 in head, in these and all other essential respects agreeing with typical more southern representatives of the species from Missouri, Arkansas, and Texas. Specimens of this species taken since 1894 in the Illinois River at Havana and Meredosia have the body more or less robust, dorsal spines short, 2.3 to 2.7 in head, and pectorals reaching but little beyond the back of the cheek in adults, their length 1.4 to 1.6 in head. These differences are seen to be less important after comparison of specimens from different southern localities, some of which are quite intermediate between the two extremes just described. Southern specimens examined, however, agree in most instances more nearly with the types of *L. garmani* than with the form from the Illinois River.

Lepomis megalotis (Rafinesque).

Lepomis megalotis, Jordan & Evermann, Bull. U.S. Nat. Mus., No. 47, p. 1002.

Generally distributed in Illinois, in the clearer portions of the swifter streams and brooks.

Lepomis humilis (Girard).

Lepomis humilis, Jordan & Evermann, Bull. U. S. Nat. Mus., No. 47, p. 1004.

The peculiar structure and coloration of the opercular flap gives to this fish a unique place among the species of the genus *Lepomis*.

Widely distributed over Illinois, except in the northern part.

Lepomis pallidus (Mitchill).

Lepomis pallidus, Jordan & Evermann, Bull. U. S. Nat. Mus., No. 47, p. 1005.

In our collections from Lake Michigan and the streams and lakes of the northern part of the state to the waters of Union county. The most abundant sunfish by far in the Illinois River.

Eupomotis Gill & Jordan.

Lower pharyngeals deep and broad, with inferior and lateral prominences, never flattened or hollowed out underneath as in *Lepomis*; width in length of toothed portion about 2 in adults; inner angle 95° to 111°; outer margin a double curve. moderately inbent posteriorly, in front of spur. and more or less decidedly rounded anteriorly, as the margin of a lateral ledge-like prominence; teeth on lower pharyngeals short and heavy, their upper surfaces very bluntly rounded or paved. Red or orange on posterior portion of opercular flap definitely marked off from the paler or blackish portions adjacent, and not blended with them as in the preceding genus. Body more or less compressed and back elevated. Mouth rather small; no supplemental maxillary bone and no teeth on palatines. Gill-rakers always short. sometimes very much reduced. Pectoral fins always longer than head, sometimes extending past middle of anal. Dorsal spines rather higher than in most species of *Lepomis*. Two species found in Illinois.

KEY TO THE SPECIES OF THE GENUS EUPOMOTIS FOUND IN ILLINOIS.

a. Pectorals reaching to or beyond middle of anal; wavy lines on cheeks faint. . . . . *heros*.

aa. Pectorals scarcely reaching front of anal; evident wavy lines of emerald on cheeks. *gibbosus*.

Eupomotis heros (Baird & Girard).

Eupomotis heros, Jordan & Evermann, Bull. U. S. Nat. Mus., No. 47, p. 1007.

Rare in Illinois, mostly from the southern part. Not taken since 1882.

Eupomotis gibbosus (Linnæus).

Eupomotis gibbosus, Jordan & Evermann, Bull. U.S. Nat. Mus., No. 47, p. 1009.

Widely distributed in Illinois, except in the Wabash basin.

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BULLETIN

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URBANA, ILLINOIS, U. S. A.

VOL. VII. MAY, 1905. ARTICLE IV.

ON A NEW SHOVELNOSE STURGEON FROM THE MISSISSIPPI RIVER.

(PLATES IV.—VII.)

BY

S. A. FORBES, PH.D., AND R. E. RICHARDSON, A.M.

Parascaphirhynchus albus Forbes & Richardson

Scaphirhynchus platorhynchus Rafinesque.

ARTICLE IV.—*On a New Shovelnose Sturgeon from the Mississippi River (Plates IV.—VII.).* BY S. A. FORBES AND R. E. RICHARDSON.

In the course of our studies of the fishes of Illinois, made in connection with the preparation of a report upon the ichthyology of the state, it became necessary last year to examine greater numbers of the larger species of the Mississippi River than could well be preserved in collections. Consequently, in June, 1904, Mr. Richardson visited for this purpose the fishing grounds at Grafton, Illinois, at the mouth of the Illinois River, and the fish boats at Alton, where the catches from that part of the Mississippi and from the lower Illinois are mainly handled by the firm of Ashlock & Son, long established at that point.

Mr. H. L. Ashlock of this firm expressed at this time his belief that a distinct sturgeon, known to the fishermen of the locality as the "white sturgeon," was occasionally obtained among the catches of the common shovelnose locally called the "switch-tail," an opinion presently confirmed by the receipt of one specimen of this species and the head of another, brought in by his fishing crews. Seven additional specimens have since been sent us by Mr. Ashlock, all taken in fyke-nets at or near Grafton.

The failure of students of American ichthyology to distinguish this species can be accounted for only on the supposition that specimens of it have never come to their notice, since its distinguishing characters are too obvious and important to have been overlooked. Its uniformly light color, relatively long head, very small eye, sharp and elongate snout, naked breast and belly, relatively small and numerous dermal scutes, numerous ribs, and few-pointed gill-rakers, separate it sharply from the common shovelnose. Its scarcity must doubtless explain its absence from our literature. According to Mr. Ashlock's estimate, about one in five hundred of the shovelnose sturgeons taken in the central Mississippi belongs to this new species, and

as the number of these sturgeons examined by all the ichthyologists of America taken together, doubtless falls far short of five hundred, it is not remarkable that it has hitherto been overlooked.

Recognizing, as we are disposed to do, the generic criteria proposed for the scaphirhynchoids by Berg ('04), we regard this form as generically distinct from species hitherto described.

PARASCAPHIRHYNCHUS, gen. nov.

Snout broad, shovel-shaped; caudal peduncle long and flattened above, broader than deep, and completely covered by scutes. Breast and belly naked, sides sprinkled with small discoidal ossifications. Lips four-lobed; spiracles and pseudobranchs wanting; gill-rakers fan-shaped, two- or three-pointed on the lower half of the arch; ribs twenty or twenty-one; air-bladder well developed, about 8 times in length of head and body.

One species; known at present only from the Mississippi River.

Parascaphirhynchus albus, sp. nov.

Head long, 2.9 to 3.2 in total length, and the body comparatively short; depth, 7.5 to 9 in length of head and body; distance from gill-cavity to front of dorsal 2.5 in total length. Color very light, the upper parts bluish gray in life, the lower parts of the sides and belly shading from very light gray to almost milky white.

Scutes small (Pl. VI.), sixteen to nineteen in the dorsal row, forty-one to forty-seven in the lateral, and ten to thirteen in the ventral. Spines of the dorsal and lateral scutes sharp, projecting strongly backward, and reaching to near the posterior border of the scute. Denticulated ossifications between the dorsal and lateral, and lateral and ventral rows of scutes diminishing in size and abundance from above downward. A few imperfect plates along the dorsal row of scutes, extending as far forward as the backward reach of the pectorals, more numerous and larger backwards, and becoming continuous with

the dorsal covering of the caudal peduncle. Belly wholly naked in front of ventrals; breast with a few bony points similar to those on the lower part of the sides. The pectoral shields are long and narrow (Pl. V.), the triangular, posterior part equaling in area the remainder of the shield.

Rostrum long and narrow (Pl. V.), 2.5 to 2.9 in length of head; the eye very small, 8.3 to 10 in the interorbital space, which is 3.7 to 4.2 in the length of the head. Barbels doubly pectinated on the anterior edge, the posterior pectinations obsolete or wanting, the inner barbels 1.7 to 2.9 in length of outer. Mouth large, 1.4 to 1.6 in the greatest width of the rostrum. Papillæ of the four clusters on the lower lip reduced to a few flattened scallops at the hinder edge of the lappet.

Gill-membranes united to the isthmus and to each other in a deep angle (Pl. V.), and continued backward to cover the anterior fourth of the pectoral shields. Operculum long and narrow, its depth contained more than twice in distance from posterior margin of cheek to posterior margin of gill-opening, and this distance about 8.5 times in length of head and body. Gill-rakers 10 or 11,+3, the two rows of each arch separated by a broad smooth surface (Pl. VII.).

Dorsal fin of 35 to 43 rays, the length of its base 11.8 to 12.8 in length of head and body; anal rays 20 to 23, ventral rays 23 to 26.

Length of our seven specimens 19 to 43 inches, to base of caudal fin, the largest weighing 9.75 pounds. Mr. Ashlock has seen specimens 4.5 feet long, with an estimated weight of 16 pounds.

Described from 9 specimens.

The sexual differences are not known, all our specimens being males. The species is said by Mr. Ashlock to spawn between March and June, and to continue spawning sometimes as late as August. The testes were well developed in those taken about the middle of June.

Although seen by us only from the Mississippi River at Grafton, this fish is said by Mr. Ashlock to be more abundant along the lower Missouri. Catches of sturgeon were seen by

him at West Alton, Mo., in which a fifth of the number were of this species. It is also said by him to occur, as a rule, in swifter water than the common shovelnose.

The following table exhibits some of the more important differences observed in comparing our nine specimens of *Parascaphirhynchus albus* with twenty-one specimens of *Scaphirhynchus platorhynchus* in the Laboratory collection.

	P. albus	*S. platorhynchus*
Ribs	20 or 21	10 or 11
Ventral radials	9	7
Gill-rakers (points)	2 or 3	2–5 (usually 4 or 5
Air-bladder in length head and body	8	5
Belly and breast	naked	fully armored
Sides between scutes	scattered ossifications	" "
Depth lateral scutes in length head and body	28—32.5	19.8—23.8
Eye in interorbital space	8.3—10	5.3—8.3 (usually less than 7)
Inner barbel in outer	1.7—2.9	1.1—1.4
Width mouth in width snout	1.4—1.6	1.6—1.9
Width head in length head	2.5—2.9	1.9—2.2
Length head in length head and body	2.9—3.2	3.5—3.8

The first of the shovelnose sturgeons was described in 1820 by Rafinesque as *Acipenser platorhynchus*, and was, in 1835, made by Heckel the type of a new genus distinguished from *Acipenser* by the absence of spiracles. The first of the Asiatic species was described by Kessler from the Suir-dar in 1872 as *S. fedtschenkoi*; the second, *S. kaufmanni*, by Bogdanov in 1875; and the third in 1877 from the Amu-dar as *S. hermanni* by Kessler, who also discussed and figured Bogdanov's species. A fourth species was described by Nikolsky in 1900 as the type of a new genus, *Pseudoscaphirhynchus*. Berg ('04) unites the three preceding species under this genus, but does not recognize Nikolsky's species as distinct.

The American and Asiatic species were first subjected to detailed anatomical analysis by Brutzer ('59) and Iwanzow ('87), the memoir of the latter being our fullest treatise on its subject. Zograff wrote in 1887, and again in 1896, especially on the embryonal teeth of these and other cartilaginous ganoids.

The two genera above mentioned have recently been studied by Berg ('04).

The following analytical table will serve to exhibit the relations of the three genera here recognized, the characters of the Asiatic genus being derived by us from the papers of Berg, Nikolsky, and Kessler.

A. Caudal peduncle shortened and laterally compressed as in *Acipenser*, the rows of scutes not meeting above and below to form a complete armor; mouth as in *Acipenser*, the lips two-lobed* and without clusters of papillæ; gill-rakers lance-shaped as in *Acipenser*; air-bladder small or rudimentary†; ribs numerous.‡

Pseudoscaphirhynchus Nikolsky.

AA. Caudal peduncle lengthened, depressed, broader than deep, and completely armored; lips four-lobed, each lip bearing four clusters of flattened tubercle-like lappets; gill-rakers fan-shaped, two-, three-, four-, or five-pointed on the lower half of the arch.

b. Ribs twenty or twenty-one; gill-rakers two- or three-pointed; belly and breast naked; air-bladder 8 in length of head and body.

Parascaphirhynchus, gen. nov.

bb. Ribs ten or eleven; gill-rakers two-, three-, four-, or five-pointed; belly and breast wholly covered with subrhombic plates; air-bladder 5 in length of head and body.

Scaphirhynchus Heckel.

Issued May 15, 1905.

*See Berg, Zool. Anz., XXVII., 22, 1904, p. 667; also Kessler's fiugres of *P. kaufmanni* and *hermanni*, Aralo-Caspian Exped., IV., 1877, Fig. 25 and 26.

†One twenty-seventh of length of head and body in *P. fedtschenkoi*.

‡Twenty-four or twenty-five in *P. fedtschenko*

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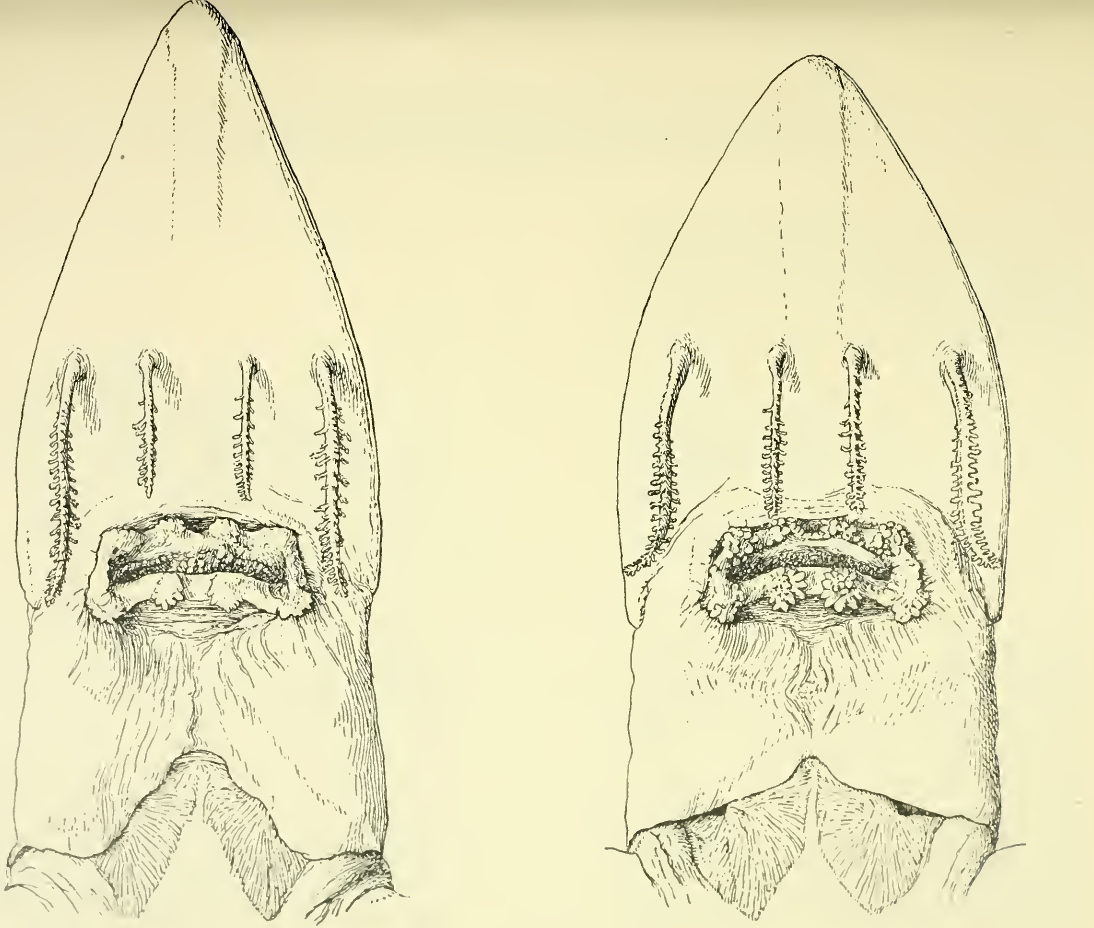
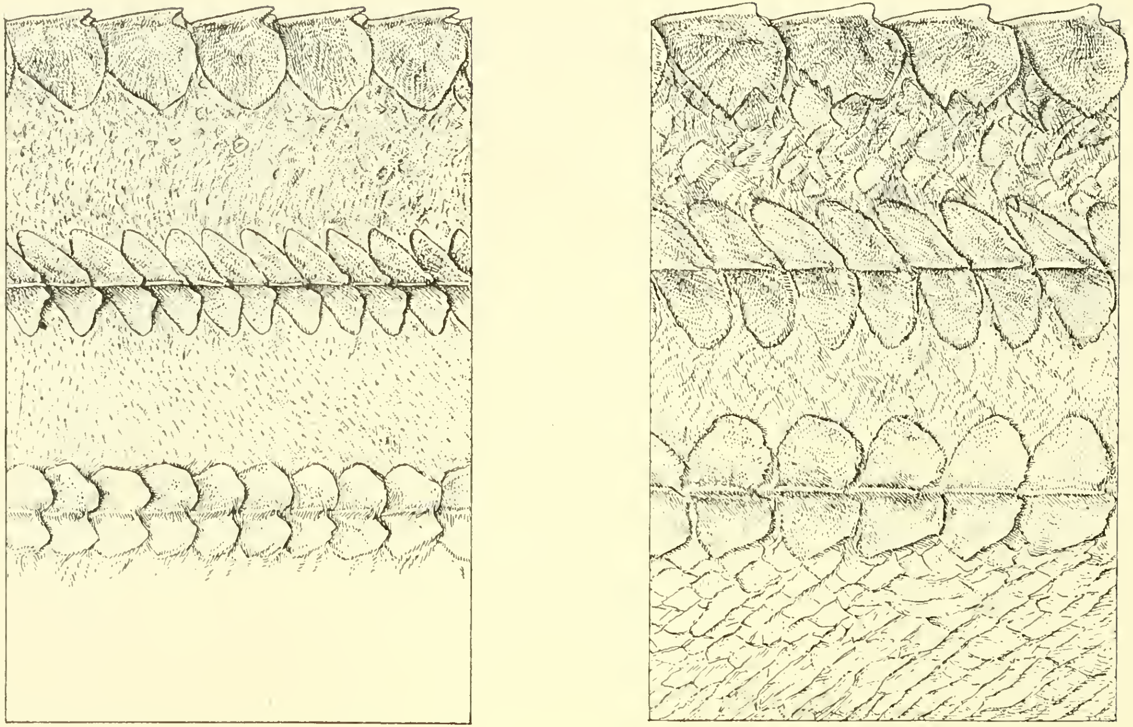
V.



(1) (2)

Ventral view of head of (1) *Parascaphirhynchus albus* and (2) *Scaphirhynchus platorhynchus* Two thirds natural size.

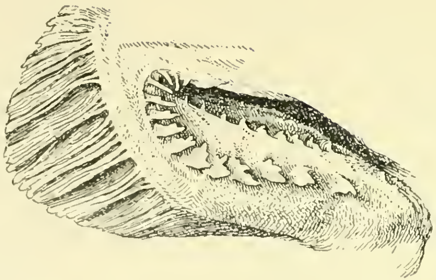
VI.



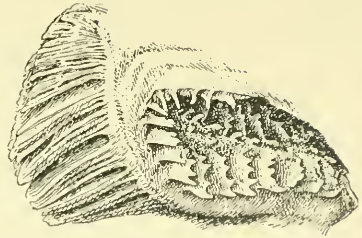
(1) (2)

Section of dermal armor of side and belly of (1) *Parascaphirhynchus albus* and (2) *Scaphirhynchus platorhynchus*. Five sixths natural size.

VII.



(1)



(2)

Gill-rakers of right outer arch of (1) *Parascapirhynchus albus* and (2) *Scaphirhynchus platorhynchus.* Natural size.

BULLETIN

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URBANA, ILLINOIS, U. S. A.

VOL. VII. DECEMBER, 1905. ARTICLE V.

NOTES ON SPECIES OF NORTH AMERICAN OLIGOCHÆTA. V. THE SYSTEMATIC RELATIONSHIPS OF LUMBRICULUS (THINODRILUS) INCONSTANS (SMITH).

BY

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DECEMBER 26, 1905.

Article V.—*Notes on Species of North American Oligochæta. V. The Systematic Relationships of Lumbriculus (Thinodrilus) inconstans* (Smith). By Frank Smith.

When this species was described by the writer (1895) it was thought that the differences between it and previously described species were such as to warrant the recognition of a new genus; hence the genus *Thinodrilus*. Michaelsen in his great work on the *Oligochæta* (1900) saw fit to include this species in the genus *Trichodrilus* Claparède with the two European species. Recent papers on the reproductive organs of *Lumbriculus variegatus* (Müller) by Wenig (1902) and Hesse (1902) have extended our knowledge of that species and have shown that it is in some particulars very similar to *Thinodrilus inconstans*, and as it now seems to the writer that there is more reason for including the latter species in the genus *Lumbriculus* than in the genus *Trichodrilus*, it will be referred to in the following discussion as *Lumbriculus inconstans*.

We will first consider the chief points in which *L. inconstans* differs more from *L. variegatus* than from the two species of *Trichodrilus* (*T. allobrogum* Claparède and *T. pragensis* Vejdovsky).

Albumen Gland.—An albumen or copulatory gland, which is described and figured by Vejdovsky (1884) as occurring in somite IX in *L. variegatus*, is lacking in *Trichodrilus* and in *L. inconstans*. No reference is made to such an organ by Wenig and Hesse in their recent papers on *L. variegatus*, and Michaelsen (1903, p. 60) has recently raised the question as to its occurrence, and queries whether the structures seen by Vejdovsky may not have been rudiments of efferent reproductive organs. It should not be overlooked that the structure of the albumen gland is described by Vejdovsky (1884, p. 149) as similar to that of the spermathecæ, and that Wenig (1902) describes and figures a single spermatheca in IX but makes no reference to an albumen gland. Vejdovsky used the presence

or absence of an albumen gland as the basis for the separation of the *Lumbriculidæ* into two groups, but without presenting any reason for believing that such a character should be considered of especial importance in determining systematic relationships, and I am disposed to assume that it has at the most no greater significance than that of a specific character.

Positions of Spermiducal Pores and Gonads.—The spermiducal pores are usually on VIII in *L. variegatus*, but Vejdovsky (1895) found them on VII in one specimen. Wenig found but one spermiducal pore in each of the specimens examined by him, and that on VIII. In *L. inconstans* the spermiducal pores are on X in two of the specimens studied and on XI in another. In the two species of *Trichodrilus* they are on X. With such individual variability in mind, it seems reasonable to consider the position of the spermiducal pores as of no more than specific importance. In *L. variegatus* there is one pair of testes and one pair of spermiducal funnels in VIII, and there are two pairs of ovaries in IX and X. In *L. inconstans* there are two pairs of testes and two pairs of spermiducal funnels in IX and X, and two pairs of ovaries in XI and XII. In the European species of *Trichodrilus* there is uncertainty about the testes. There are two pairs of spermiducal funnels in IX and X and one pair of ovaries in XI. With reference to the position of the gonads our species is nearer to *Trichodrilus*, while in respect to the number of ovaries it is more like *L. variegatus*.

We will next consider several important respects in which *L. inconstans* more closely resembles *L. variegatus* than it does the European species of *Trichodrilus*.

Setæ.—In *L. variegatus* and *L. inconstans* the setæ are cleft; in *Trichodrilus* they are simple. While it is true that in some lumbriculid species the setæ may be partly simple and partly cleft, yet to my knowledge there has been no occasion for placing in the same genus species with setæ all simple and other species with setæ all cleft, except in the genus *Trichodrilus* as defined by Michaelsen (1900, p. 58) in order that it might include the species *inconstans*.

Vascular System.—In *L. variegatus* a pair of transverse vessels connects the dorsal and ventral vessels in each of several anterior somites. They are situated just anterior to the septum. They are small in somites back of XX, and are so close to the wall of the intestine and so covered by chloragogue cells that they are seldom recognizable. A single pair of cæciform, contractile, branched vessels, connected only with the dorsal vessel, is contained in the anterior part of each somite posterior to XV (Ratzel, 1868), and, according to Dieffenbach (1886), smaller ones are found as far forward as IX. The description of the circulatory system of *L. inconstans* in my earlier treatment of that species (1895) was very incomplete and did not give enough data for comparisons, but as far as transverse vessels are concerned the conditions existing in that species and in *L. variegatus* are closely similar. In *L. inconstans* the paired vessels which connect the dorsal and ventral vessels, in the posterior part of each somite, are recognized with difficulty posterior to XVII, and the cæcal branches of the dorsal first appear in XI and then occur regularly, there being one pair, and only one, in each somite. In each of the two species of *Trichodrilus*, in the middle region of the body there are four or more cæcal branches of the dorsal vessel on each side in each somite, instead of a single one as in each species of *Lumbriculus*.

Spermathecæ.—In *L. variegatus* there is much variability in the position and arrangement of the spermathecæ. Vejdovsky reported three pairs in X—XII; Hesse found four pairs in X—XIII; and Wenig found them more or less asymmetrically distributed in IX—XV. In *L. inconstans* I have found five pairs in XI—XV or in XII—XVI. In *Trichodrilus* but one or two pairs are found, and these are in XI or in XI and XII. The spermathecal pores of both species of *Lumbriculus* are at least as high up on the sides as the ends of the transverse diameter, while the pores of both species of *Trichodrilus* are described as behind the ventral setæ.

Atrium and Penis.—Vejdovsky (1895) describes and figures the atrium and penis of *L. variegatus*. Hesse did not at first (1894) recognize the presence of the penis, but later (1902) reexamined his preparations and found it to be present. Wenig confirmed the observations of Vejdovsky. In my former description of *L. inconstans* the following statement occurs: "Whether or not a definite penis is developed I am unable to state." A reexamination of my specimens has revealed the presence of a penis, formerly overlooked because of its great transparency. This organ and the atrium are both very similar to those of *L. variegatus*.

Besides these more important characters in which L. *inconstans* resembles *L. variegatus* much more closely than it does the species of *Trichodrilus*, there are others of less importance, but nevertheless significant, in which the two former species are closely similar. (1) They are both greenish anteriorly. (2) The usual number of somites in each is more than double the number in the two species of *Trichodrilus*. (3) They are noticeably similar in the extreme infrequency with which sexually mature specimens are found. I have examined hundreds of specimens of *L. inconstans*, taken at various times of the year, and have found but three with reproductive organs developed. (4) The form of the brain is quite similar in the two species of *Lumbriculus* and quite different from that of *Trichodrilus pragensis* as described and figured by Vejdovsky (1876). (5) In both species of *Lumbriculus* nephridia are found in the same somite as are the genital ducts, which is not the case in *Trichodrilus*. (6) The sperm-sacs in both species of *Lumbriculus* extend posteriorly from the atrial somite through a considerable number of somites, while in *Trichodrilus pragensis* sperm-sacs are apparently formed anterior to the atrial segment as well as posterior to it (Vejdovsky, 1876, p. 548, Fig. 2).

If we follow somewhat closely the general type of generic and specific definitions adopted by Michaelsen (1900), we may define *Lumbriculus* and its two species in the following terms.

Lumbriculus Grube.

Prostomium rounded. Setæ cleft. One pair of spermiducal pores. Two pairs of oviducal pores. Three pairs, or more, of spermathecal pores, open laterally on some of somites IX—XVI. Dorsal and ventral vessels connected in posterior part of each somite by a pair of transverse vessels; the dorsal vessel in each somite with one pair of contractile cæcal transverse appendages except in a few anterior somites. Sperm-ducts open into a single atrium or pair of atria provided with protrusible penis. Two pairs of ovaries and of oviducal funnels. Spermathecæ simple; three pairs or more in somites posterior to atria.

Lumbriculus variegatus (O. F. Müller).

In life reddish to dark brown, anteriorly greenish. Prostomium rounded conical, length $1\frac{1}{2}$ times the basal width, with "head" pore at the apex. Spermiducal pores on VIII (exceptionally on VII), posterior to ventral setæ. Two pairs of oviducal pores, IX/X and X/XI. Spermathecal pores on some of somites IX—XV, sometimes asymmetrically distributed. Brain anteriorly slightly concave, posteriorly with a deep, rounded trilateral incision. Transverse vessels of I—VIII much branched, forming a connected vascular plexus, the following ones simple; contractile cæcal transverse appendages of the dorsal vessel beginning in IX, at first short and simple but becoming longer and branched in succeeding somites. One pair of testes and one pair of spermiducal funnels in VIII. Atria pyriform, one pair in VIII (exceptionally in VII), or single. Two pairs of ovaries and of oviducal funnels in IX and X. Spermathecæ simple, three pairs or more in some of somites IX—XV, sometimes asymmetrically distributed. An unpaired copulatory (albumen) gland in IX. (?) Length, 40—80 mm. Diameter, 1—1.5 mm. Number of somites, 140—200, or more.

Lumbriculus inconstans (Smith).

In life reddish, anteriorly greenish. Prostomium rounded, length $1\frac{1}{2}$ times the basal width. Spermiducal pores on X (exceptionally on XI). Two pairs of oviducal pores, XI/XII and XII/XIII. Spermathecal pores on XI—XV or XII—XVI. Brain anteriorly, but slightly, concave, posteriorly with a deep, rounded trilateral incision. Contractile cæcal transverse appendages of the dorsal vessel beginning in XI, becoming larger and more branched in succeeding somites. Two pairs of testes and two pairs of spermiducal funnels in IX and X. Atria pyriform, one pair in X (exceptionally in XI). Two pairs of ovaries and two pairs of oviducal funnels in XI and XII. Five pairs of spermathecæ in XI—XV or XII—XVI. No copulatory (albumen) gland. Length, 30—60 mm. Diameter, .6—.8 mm. Number of somites, 150—200, or more.

If the above disposition of the two species under discussion be correct, and if the views of Michaelsen (1902) concerning the phylogenetic relationships of the lumbriculid genera are well founded, the species *inconstans* seems to have the more primitive condition of spermiducal structures, and *L. variegatus* may have been derived from it by the disappearance of the anterior pair of testes and of sperm-ducts and a reduction in the number of anterior somites. The specimen of *L. inconstans* referred to above, in which the spermiducal pores are on a somite posterior to the somites containing the testes, presents a condition normal to families higher than the *Lumbriculidæ* but not ordinarily found in that family.

The transfer of the American species from the genus *Trichodrilus* to *Lumbriculus* leaves the former genus much more homogeneous and simplifies its definition.

University of Illinois, December 16, 1905.

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A CATALOGUE OF THE MOLLUSCA OF ILLINOIS.

BY

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Curator of the Chicago Academy of Sciences.

Map of Illinois, showing the number of species of mollusks which have been recorded from each county. The higher figures indicate in which counties systematic work has been done.

JO DAVIESS
STEPHENSON
WINNEBAGO
BOONE
McHENRY
LAKE
CARROLL
OGLE
KANE
COOK
WHITESIDE
DEKALB
DUPAGE
LEE
Green R.
Rock R.
ROCK ISLAND
BUREAU
KENDALL
Des Plaines R.
LA SALLE
WILL
HENRY
PUTNAM
GRUNDY
MERCER
STARK
MARSHALL
Vermilion R.
Kankakee R.
KANKAKEE
HENDERSON
KNOX
LIVINGSTON
WARREN
PEORIA
WOODFORD
IROQUOIS
Spoon R.
Illinois R.
Mackinaw R.
FULTON
TAZEWELL
FORD
HANCOCK
McDONOUGH
McLEAN
VERMILION
Big Vermilion R.
MASON
LOGAN
DEWITT
CHAMPAIGN
SCHUYLER
ADAMS
BROWN
CASS
MENARD
MACON
Sangamon R.
PIATT
MORGAN
SANGAMON
PIKE
SCOTT
DOUGLAS
EDGAR
MOULTRIE
COLES
CHRISTIAN
SHELBY
MISSISSIPPI RIVER
CALHOUN
GREENE
MONTGOMERY
CUMBERLAND
CLARK
MACOUPIN
JERSEY
JASPER
FAYETTE
EFFINGHAM
CRAWFORD
Embarras R.
MADISON
BOND
RICHLAND
LAWRENCE
CLINTON
MARION
CLAY
ST CLAIR
WAYNE
EDWARDS
WABASH
Wabash R.
Kaskaskia R.
WASHINGTON
MONROE
JEFFERSON
Little Wabash R.
RANDOLPH
PERRY
FRANKLIN
HAMILTON
WHITE
Big Muddy R.
JACKSON
SALINE
GALLATIN
WILLIAMSON
Saline R.
UNION
JOHNSON
POPE
HARDIN
RIVER
ALEXANDER
PULASKI
MASSAC
OHIO
...... Ill. and Mich. Canal
Ill. and Miss. Canal
...... Drainage Canal
. County Seat.

Article VI.—*A Catalogue of the Mollusca of Illinois.* By Frank Collins Baker.

Introductory.

The following catalogue of Illinois mollusks is intended to record every reference to the Mollusca occurring in the state which may be found in the few published lists, and also all scattered references to the same, wherever published. The bibliography is believed to contain a majority of the publications referring to the Mollusca of the state, but it can scarcely be complete, since references probably exist which are unknown to the author.

The classification is that of Dall, Pilsbry, and Simpson. The valid species (so considered at the present time) overhang at the margin, while those specific names which have been used in Illinois references and which are now considered synonyms follow in parenthesis. In indicating the geographical distribution the author has deemed it best simply to quote every locality from which specimens have been recorded, adding after each locality, in parenthesis, the name of the collector or author who is authority for the same. By this means an exact census of our molluscan fauna will be secured, based on actual collections. There have been several references to species which are evidently founded on misidentifications. These are indicated in foot-notes under their respective genera. Several species are listed on the authority of correspondents, and the identifications have not been verified.

Acknowledgments are due to the following Illinois conchologists, who kindly furnished more or less exhaustive lists: Mr. A. A. Hinkley, DuBois; Mr. J. H. Ferriss and Mr. J. H. Handwerk, of Joliet; Mr. W. A. Marsh, Aledo; Dr. W. A. Nason, Algonquin; Dr. W. S. Strode, Lewiston; and Mr. Charles A. Hart, of Urbana. The following persons have also aided in the work, either by presenting collections to the Chicago Academy

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The following gentlemen have kindly identified the groups indicated, and my thanks are due to them: Dr. H. A. Pilsbry, Academy of Natural Sciences, Philadelphia, Penn., various land and fresh-water shells; Mr. Bryant Walker, Detroit, Mich., *Ancyli* and other fresh-water shells; and Dr. V. Sterki, New Philadelphia, Ohio, *Corneocyclas* and *Pupidæ*. These gentlemen have also identified considerable material in the State Laboratory collection.

My thanks are especially due to Prof. S. A. Forbes, Director of the State Laboratory of Natural History, Urbana, for the privilege of studying and listing the very large collection of Illinois mollusks under his charge.

This catalogue is but a tentative list, and additions and corrections are earnestly solicited from all interested persons.

In the following pages the writer has aimed to present a condensed survey of our knowledge concerning the molluscan fauna of the state of Illinois. The position of the state, lying, as it does, with the Mississippi River on the west, the Wabash River on the east, the Ohio River on the south, and Lake Michigan on the north, not to speak of the Illinois, Kaskaskia, Rock, and other rivers intersecting the state, is particularly favorable to the presence of a varied and abundant molluscan fauna. The rich woodlands bordering or near the watercourses also afford favorite retreats for the terrestrial species, about one sixth of the surface being forest-covered.

There are two main drainage areas, one, very small, in the northern part of the state, draining into Lake Michigan, and the other, including the larger part of the state, draining into the Mississippi River by way of the Illinois, Rock, Fox, Desplaines, Kankakee, Wabash, and Ohio, and other rivers and streams. When the state is more thoroughly explored conchologically it will probably be found that its mollusks will show peculiar geographical variations due to its extent through five and a half degrees of latitude (from 37° to 42½°).

While the literature relating to the Mollusca of Illinois is rather extensive, it is a singular fact that not one catalogue has been published which gives a list of all of the species of the state. Some of the more extensive catalogues which have been published are mentioned below.

In 1854 Mr. H. A. Ulffers published a list of the Mollusca of Southern Illinois in the Transactions of the Illinois Horticultural Society (Vol. I., p. 610). This included 87 species. Of these, 14 are now considered synonyms.

In 1871 Mr. John Wolf published his "Catalogue of the Shell-bearing Mollusca of Fulton County, Illinois," in the American Journal of Conchology (Vol. VI., p. 27), listing 138 species, of which 8 are now considered synonyms.

In 1874 Mr. W. W. Calkins listed the Mollusca of Northern Illinois in the Cincinnati Quarterly Journal of Science (Vol. I., p. 321). This list included 129 species, of which but 6 are now considered synonyms. The same author, in the Proceedings of the Ottawa Academy of Sciences for 1874, enumerates 105 species as occurring in La Salle County.

In 1887–89 Mr. William A. Marsh enumerated 110 species of land and fresh-water shells as found in Mercer county, his lists being published in the Conchologist's Exchange (Vol. I. and II.) and in the Nautilus (Vol. III.). Several of the species listed are now considered synonyms.

Dr. W. S. Strode (Nautilus, Vol. V., p. 61, American Naturalist, Vol. XXVI., p. 495) enumerates 35 species, mostly Unios, from Spoon River, near Bernadotte.

In 1898 Mr. John W. Huett published a volume on "The Natural History of La Salle County, Illinois," in which (Part II., p. 96) 92 species of land and fresh-water shells are listed.

In 1898–1902 Mr. Frank C. Baker published a report on "The Mollusca of the Chicago Area", in which 164 species are recorded for Cook, Du Page, and Will counties.

In addition to these more or less extensive lists, numerous papers have been published in which Illinois shells are mentioned, and also quite a number which are devoted to critical remarks or notes on the geographic distribution or economic value of Illinois mollusks. The works of Binney, Bland, Conrad, Haldeman, Küster, Lea, Pilsbry, Prime, Say, Simpson, Sterki, Tryon, and Walker contain many references to Illinois species, as well as descriptions of some species new to science.

There have been twenty-eight species and varieties new to science described from Illinois specimens. These are as follows:

Unio upsoni Marsh. Mercer County.
Sphærium lilycashense Baker. Lilycash Creek.
" *stamineum forbesi* Baker. Matanzas Lake.
Musculium hodgsoni Sterki. Albion.
Corneocyclas handwerki Sterki. Lilycash Creek.
" *roperi* Sterki. Higginbotham's Spring, Joliet.
Campeloma subsolidum Anthony. Illinois.
Amnicola pilsbryi Walker. Rockford.
Pyrgulopsis mississippiensis Pilsbry. Mississippi River, near Rock River.
" *scalariformis* Wolf. Tazewell Co. shore, Illinois River.
Pleurocera lewisii Lea. Peoria.
" *moniliferum* Lea. Ohio River, near its mouth, in Illinois.
Goniobasis grosvenorii Lea. Fox River.
Physa hildrethiana Lea. A lake in Illinois.
" *elongata* Say. Shores of Illinois.
Lymnæa tazewelliana Wolf. Tazewell Co. shore, Illinois River.
" *woodruffi* Baker. Lake Michigan.
" *ferrissii* Baker. Joliet.
" *sufflatus* Calkins. Calumet River, Chicago.
" *reflexa jolietensis* Baker. Joliet.
" *reflexa crystallensis* Baker. Crystal Lake.
Vallonia parvula Sterki. Joliet.
Zonites upsoni Calkins. Rockford.
Vertigo tridentata Wolf. Canton.

Succinea calumetensis Calkins. Calumet Marshes, Chicago.
" *peoriensis* Wolf. Peoria.
" *illinoisensis* Wolf. Canton.
Polygyra multilineata algonquinensis Nason. Algonquin.

Of the above list the following are now considered synonyms of other species:

Unio upsoni = *Lampsilis ligamentina* Lamarck.
Goniobasis grosvenorii = *Goniobasis semicarinata* Say.
Physa elongata = *Aplexa hypnorum* Linné.
Lymnæa ferrissii = *Lymnæa caperata* Say.
" *sufflatus* = *Lymnæa palustris* Müller.
Zonites upsoni = *Vertigo ovata* Say.
Succinea calumetensis = *Succinea retusa* Lea.

Illinois lies wholly within Binney's Interior Region of the Eastern Province. Of the 69 species mentioned by Binney as inhabiting this region, all but 8 have been found in Illinois. It will thus be seen that the Illinois molluscan fauna is typical of the interior region. Among the land shells the families *Zonitidæ* and *Helicidæ* are represented by the largest number of species; among the genera, *Polygyra* is the most noteworthy.

The Mississippi Valley is the metropolis of the pearly freshwater mussels (*Unionidæ*), and the position of the state, bordered on the west by the Mississippi River and on the south and east by the Ohio and Wabash rivers, has produced a large and varied *Unio* fauna, no less than 98 species and varieties being found in the various rivers and lakes. The *Sphæriidæ, Viviparidæ, Amnicolidæ, and Lymnæidæ* are also notably developed.

The fluviatile species are distributed among 9 families and 47 genera. Of these, 2 families and 25 genera are bivalves, 3 families and 7 genera are pulmoniferous, and 4 families and 15 genera are branchiferous and operculate, as is evident from the following list.

FLUVIATILE MOLLUSKS.

Family.	Genus.	No. of Species.	No. of Varieties.
Unionidæ	*Truncilla*	6	1
	Lampsilis	24	
	Micromya	1	
	Obovaria	4	

Family.	Genus.	No. of Species.	No. of Varieties.
Unionidæ [Cont.]	*Plagiola*....................	3	
	Tritogonia	1	
	Cyprogenia	1	
	Obliquaria	1	
	Ptychobranchus.............	1	
	Dromus.....................	1	
	Strophitus..................	1	1
	Anodonta..................	6	2
	Lastena	1	
	Anodontoides...............	1	1
	Arcidens....................	1	
	Symphynota	3	
	Alasmidonta...............	2	
	Hemilastena	1	
	Margaritana...............	2	
	Unio.......................	3	2
	Pleurobema................	3	
	Quadrula..................	22	2
Sphæriidæ	*Sphærium*	9	1
	Musculium	9	
	Corneocyclas...............	24	5
Viviparidæ	*Vivipara*...................	3	1
	Campeloma.................	6	2
	Lioplax....................	1	
Valvatidæ	*Valvata*....................	4	3
Amnicolidæ	*Bythinia*..................	1	
	Amnicola	7	3
	Paludestrina	1	
	Somatogyrus...............	4	1
	Pomatiopsis	3	
	Pyrgulopsis................	2	
Pleuroceridæ	*Angitrema*..................	2	
	Lithasia...................	2	
	Pleurocera	12	2
	Goniobasis	9	
	Anculosa..................	3	
Physidæ	*Physa*.....................	9	2
	Aplexa....................	1	
Ancylidæ	*Ancylus*...................	10	1
	Gundlachia	2	
Lymnæidæ	*Lymnæa*	15	13
	Planorbis	12	1
	Segmentina................	1	
	Total...............	241	44

The terrestrial forms are distributed among 14 families and 27 genera.

TERRESTRIAL MOLLUSKS.

Family.	Genus.	No. of Species:	No. of Varieties.
Helicinidæ	*Helicina*	1	
Auriculidæ	*Carychium*	2	
Valloniidæ	*Vallonia*	3	
Pupidæ	*Strobilops*	3	
	Pupoides	1	
	Bifidaria	7	1
	Vertigo	5	1
	Pupilla	1	
Cochlicopidæ	*Cochlicopa*	1	
Succineidæ	*Succinea*	9	3
Helicidæ	*Polygyra*	21	6
Achatinidæ	*Opeas*	1	
Testacellidæ	*Testacella*	1	
Circinariidæ	*Circinaria*	1	
Zonitidæ	*Omphalina*	4	
	Vitrea	5	
	Vitrina	1	
	Euconulus	2	1
	Zonitoides	5	
	Gastrodonta	5	
Limacidæ	*Limax*	2	
	Agriolimax	2	
Philomycidæ	*Philomycus*	1	
Endodontidæ	*Pyramidula*	4	
	Helicodiscus	1	
	Punctum	1	
	Sphyradium	1	
	Total	91	12

A comparison of our fauna with that of other states is interesting, although the comparison is scarcely accurate in one or two cases on account of the age of the records (Maine, 1864; Alabama, 1876)*.

*The figures of the following table are mostly from Mr. Bryant Walker's paper, "Revision of our Present Knowledge of the Molluscan Fauna of Michigan", 1894.

State	Catalogue	Land species	Hygrophila	Amnicolidæ	Valvatidæ	Viviparidæ	Pleuroceridæ	Sphæriidæ	Unionidæ	Total
Maine..................	Morse, 1864	50	26	4	2	1	0	12*	10	105
New York	Letson, 1905	82	36	14	2	4	9	34	59	240
Michigan..............	Walker, 1906	78	50	14	4	6	10	60	52	274
Indiana..................	Daniels, 1904	78	33	10	3	10	24	35	83	276
Illinois..................	Baker, 1906	91	50	18	4	10	28	42	89	332†
Alabama	Lewis, 1876	78	20	24‡	1§	17	302	7*	256	705

A comparison of the figures in the table will show (1) that the number of species increases toward the south and west; (2) that this increase is confined mainly to the aquatic forms; and (3) that the increase in certain families is very great. The increase in aquatic forms is shown in the following comparisons.

State.	*Land Species.*	*Aquatic Species.*
Maine..	50	55
New York..	82	158
Michigan..	78	194
Indiana..	78	198
Illinois..	91	240
Alabama..	78	627

The ratios of land to aquatic forms increase more rapidly to the south than to the west, being in New York 1 to 2, in Illinois 1 to 2½, and in Alabama 1 to 8. In Maine the ratios are nearly equal.

As to the great increase in certain families toward the south and west, Alabama has 25 times as many species of *Unionidæ* as Maine, 3 times as many as Illinois, and nearly 4½ times as

* This does not include the recently described *Corneocyclas*, which would materially increase the number of species recorded in the older lists.

† This does not include the 56 varieties enumerated in the present list.

‡ The recently described *Amnicola* and *Somatogyrus* are here included.

§ *Vide* Hinkley.

many as New York; while in the *Pleuroceridæ* this comparison is even more marked, the corresponding record being 34 times as many for New York, 30 times as many for Michigan, and about 11 times as many for Illinois. In other families the ratios are more nearly equal. In the *Hygrophila* the greatest increase is toward the west, Michigan and Illinois having the greatest number of species. In a general way we may say that the *Unionidæ*, *Pleuroceridæ*, and *Viviparidæ* are characteristic of the southern region, while the *Hygrophila*, *Valvatidæ*, and *Sphæriidæ* are characteristic of the northern region. The number of species of *Sphæriidæ* found in this state (42) is noteworthy.

A study of the published and manuscript lists of the state shows that little is known concerning the geographical distribution of our Mollusca. For only ten counties has a careful list been made. The writer has obtained records from 69 counties. the number of species ranging from 1 to 145. The following list shows the number of species known to inhabit 10 counties and 8 rivers.

Counties.		*Rivers.*	
Cook	141	Illinois	110
Fulton	145	Wabash	43
La Salle	120	Ohio	43
Will	110	Kaskaskia	19
Mercer	113	Kankakee	67
Winnebago	75	Rock	14
Mason	98	Kishwaukee	10
McHenry	89	Mississippi	56
Menard	62		
Adams	56		

The Cook county list includes 8 species which have been introduced from Europe and are now thriving in the greenhouses of Chicago.

Too little is as yet known concerning the distribution of Illinois Mollusca to permit any satisfactory generalizations. One of the reasons which prompted the preparation of the present catalogue was the hope that its publication might stimulate a desire among conchologists to prepare careful, up-to-date lists

of as many counties as possible. Much good work has been done in Indiana by Call, Daniels, and Blatchley, and the work of the Michigan conchologists under the leadership of Mr. Bryant Walker is to be highly commended. It is to be hoped that Illinois will not fall behind in this good work.

SYSTEMATIC CATALOGUE OF SPECIES.

Class PELECYPODA.

Order PRIONODESMACEA.

Superfamily Naiadacea.

Family UNIONIDÆ.

HETEROGENÆ.

Genus Truncilla Rafinesque.

Subgenus *Truncilla* Rafinesque.

Truncilla triquetra Rafinesque (=*triangularis* Lea).
Northern Illinois (Calkins); Will Co. (Ferriss); Kankakee River; Illinois River (Handwerk); La Salle Co. (Huett); Wabash River (Marsh); Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf).

Subgenus *Scalenaria* (Rafinesque) Agassiz.

Truncilla sulcata Lea.
Ohio River (Marsh).

Subgenus *Dysnomia* Agassiz.

Truncilla foliata Hildreth.
Ohio River (Marsh); Southern Illinois (Ulffers).

Subgenus *Pilea* Simpson.

Truncilla perplexa Lea.
Wabash River (Hinkley); Ohio River (Marsh); Southern Illinois (Ulffers).

Truncilla perplexa rangiana Lea.
Illinois (Call); Wabash River (Marsh); Southern Illinois (Ulffers).

Truncilla propinqua Lea.
Ohio River (Marsh).

Truncilla personata Say (=*pileus* Lea).
Southern Illinois (Ulffers).

Genus MICROMYA (Agassiz) Simpson.

Micromya fabalis Lea.
Wabash River (Marsh).

Genus LAMPSILIS Rafinesque.

Subgenus *Lampsilis* Rafinesque.

Section *Lampsilis* Rafinesque.

Lampsilis ventricosa Barnes (= *occidens* Lea, *subovata* Lea).*
Oregon, Ogle Co.; Starved Rock, La Salle Co.; Savanna, Carroll Co. (Baker); Cook Co. (Baker, Calkins); Northern Illinois; Fox River (Calkins); Dundee, Kane Co. (Engleholm, Nason); Hickory Creek; Kaskaskia River (Ferriss, Handwerk); Du Page River; Illinois River (Handwerk); Mississippi River, Quincy, Adams Co.; Mackinaw River, Kappa, Woodford Co. (Hart); Winnebago Co.; Ohio River; Kaskaskia River (Hinkley); La Salle Co. (Huett); Fulton Co. (Kelly, Wolf); Mercer Co.; Ohio River; Mississippi River (Marsh); Athens, Menard Co. (Nason); Mt. Carmel, Wabash Co. (Nelson); Spoon River (Strode); Southern Illinois (Ulffers); Embarras River, Oakland, Coles Co.; Quiver Creek, Havana, Mason Co. (State Laboratory).

Lampsilis capax Green.
Northern Illinois; Mt. Carmel, Wabash Co. (Calkins); Mercer Co. (Ferriss, Marsh); Shawneetown, Gallatin Co. (Fischer); Quincy, Adams Co. (Hart); La Salle Co. (Huett); Mississippi River (Marsh); Spoon River, Fulton Co. (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf).

Lampsilis ovata Say.
Ohio River (Marsh).

Lampsilis multiradiata Lea.
Cook Co. (Baker); Illinois (Call); Dundee, Kane Co. (Engleholm); Big Vermilion River (Marsh); Southern Illinois (Ulffers).

**Lampsilis cariosa* Say is reported by Huett from La Salle county. The reference was undoubtedly founded on specimens of *ventricosa*, as *cariosa* is a species of the Atlantic and St. Lawrence drainage.

Section *Eurynia* Rafinesque.*

Lampsilis luteola Lamarck (= *siliquoides* Barnes, *distans* Anthony).

Oregon, Ogle Co. (Baker); Cook Co. (Baker, Calkins, Higley, Jensen, Lyon, Nason); Mt. Carmel, Wabash Co. (Calkins); Northern Illinois (Calkins, Nason); Dundee, Kane Co. (Engleholm, Nason); Hickory Creek, Will Co. (Ferriss); Du Page River (Gault); Kankakee and Du Page rivers (Handwerk); Illinois River (Handwerk, Kelly); Mackinaw River, Kappa, Woodford Co. (Hart); Rock, Pecatonica, and Kishwaukee rivers, and Kent's Creek (Hinkley); Little Wabash and Big Muddy rivers (Hinkley, for *siliquoides*); La Salle Co. (Huett); Quiver Creek, Mason Co. (Kelly); Crystal Lake (Lyon); Cedar Lake, Lake Co. (Marcy); Washington Co.; Mississippi River, Mercer Co. (Marsh); Calumet River; Algonquin and Silver Lake, McHenry Co; Athens, Menard Co. (Nason); Illinois River; Spoon River (Strode); Southern Illinois (Ulffers, for *siliquoides*); Fulton Co. (Wolf); Lake Michigan, Chicago, Cook Co; Havana, Mason Co. (State Laboratory).

Lampsilis ligamentina Lamarck (=*crassa* Say).

Oregon, Ogle Co.; Savanna, Carroll Co.; Cook Co. (Baker); Northern Illinois; Mt. Carmel, Wabash Co. (Calkins); Dundee, Kane Co. (Engleholm, Nason); Kankakee River (Ferriss); Kankakee, Illinois, and Du Page rivers (Handwerk); Mississippi River, Quincy, Adams Co. (Hart); Rock, Pecatonica, Kaskaskia, Wabash, and Little Wabash rivers (Hinkley); La Salle Co. (Huett); Spoon and Illinois rivers (Kelly, Strode); Mercer Co., Mississippi River (Marsh); Athens, Menard Co; Algonquin, McHenry Co. (Nason); Southern Illinois (Ulffers); Havana, Mason Co. (State Laboratory).

Lampsilis upsoni Marsh (= *ligamentina*) is reported from Mercer Co. (Marsh) and from the Kishwaukee River (Hinkley and Marsh). Simpson (Synopsis, p. 539) makes this a synonym of *ventricosa*.

**Lampsilis propria* Lea. A specimen of this species, identified by Mr. C. T. Simpson, is in the collection of the Chicago Academy of Sciences and was received from Mr. W. W. Calkins as from the Illinois River. As this species has been found only in Virginia and Georgia the Illinois record must be considered very doubtful. The probability is that the specimen became mixed with Illinois shells.

Lampsilis orbiculata Hildreth.*

Northern Illinois (Calkins); Mississippi River, Quincy, Adams Co. (Hart, Nason); La Salle Co. (Huett); Wabash River (Marsh); Illinois River (Strode); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Lampsilis higginsii Lea.

Illinois River (Ferriss, Handwerk, Kelly); Kankakee River (Handwerk); Mississippi River (Marsh).

Lampsilis anodontoides Lea (= *teres* Say).

Savanna, Carroll Co.; Cook Co. (Baker); Mt. Carmel, Wabash Co.; Northern Illinois (Calkins); Illinois River (Ferriss, Handwerk, Strode); Shawneetown, Gallatin Co. (Fischer); Du Page Co. (Gault); all rivers visited (Hinkley); La Salle Co. (Huett); Illinois River (Kelly); Cache Creek, Pulaski Co. (Lyon); Mercer Co., Mississippi River (Marsh); Mississippi River, Quincy, Adams Co.; Athens, Menard Co. (Nason); Thompson's Lake (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co.; Fulton Co. (State Laboratory).

Lampsilis fallaciosa (Smith) Simpson.

Savanna, Carroll Co.; Cook Co. (Baker); Meredosia, Morgan Co. (Gault); Hickory Creek, Will Co. (Handwerk); Quincy, Adams Co. (Hart); Cache Creek, Pulaski Co.; Crooked and Clear creeks, Union Co. (Lyon); Mississippi River (Marsh); Havana, Mason Co.; Meredosia, Morgan Co.; Peoria, Peoria Co. (State Laboratory).

Lampsilis recta Lamarck.

Fox River (Atwater); Savanna, Carroll Co.; Cook Co; Oregon, Ogle Co. (Baker); Northern Illinois (Calkins); Fox River, Dundee, Kane Co. (Engleholm, Nason); Kankakee River (Ferriss); Illinois, Kankakee, and Du Page rivers (Handwerk); Mississippi River, Quincy, Adams Co. (Hart); Winnebago Co.; Kaskaskia River (Hinkley); La Salle Co. (Huett); Alton, Madison Co. (Kennicott); Mississippi River, Mercer Co. (Marsh); Fox River, Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Illinois and Spoon rivers and Quiver Creek, Mason Co. (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

**Lampsilis pinguis* Lea is listed by Marsh from the Illinois River. According to Simpson this species is doubtfully distinct from *orbiculata*, the type being diseased. It is recorded only from St. Peter's River, Minnesota. (Simpson's Synopsis, p. 540.)

Lampsilis subrostrata Say (= *mississippiensis* Conrad).

Peru, La Salle Co. (Derr); Lily Lake, Quincy, Adams Co. (Hart); Big and Little Muddy rivers (Hinkley); Mt. Carmel, Wabash Co.; Aledo, Mercer Co. (Lewis); Mercer Co., Mississippi River; Wabash River (Marsh).

Lampsilis nigerrima Lea.

Wabash River (Marsh). This species is recorded by Simpson from "Alexandria, Louisiana, to Eastern Texas; Indiana?"

Lampsilis lienosa Conrad (= *caliginosa* Lea).

Saline River; pond in Perry Co. (Hinkley); Little Vermilion River (Marsh); Southern Illinois (Ulffers).

Lampsilis iris Lea (= *novi-eboraci* Lea).

Cook Co. (Baker, Jensen); Northern Illinois (Calkins); Fox River, Dundee, Kane Co. (Engleholm); Du Page River (Ferriss, Gault, Handwerk); Hickory Creek, Will Co. (Handwerk); La Salle Co. (Huett); Kankakee River; Edwards Creek (Marsh); Fox River, Elgin, Kane Co.; Algonquin, McHenry Co. (Nason); Spoon River (Strode); Fulton Co (Wolf).

Lampsilis ellipsiformis Conrad (= *spatulata* Lea).

Cook Co. (Baker, Jensen); Northern Illinois; Vermilion River (Calkins); Fox River, Dundee, Kane Co. (Engleholm, Nason); Hickory Creek, Will Co. (Ferriss, Handwerk); Du Page River (Gault); Mackinaw River, Kappa, Woodford Co. (Hart); Kishwaukee River (Hinkley); La Salle Co. (Huett); Mercer Co., Edwards Creek (Marsh); Fox River, Algonquin, McHenry Co. (Nason); Fulton Co. (Wolf); Fox River (New York State Cabinet).

Subgenus *Carunculina* Simpson.

Lampsilis texasensis Lea.

Southern Illinois (Simpson).

Lampsilis parva Barnes.

Oregon, Ogle Co.; Savanna, Carroll Co.; Cook Co. (Baker); La Salle Co.; Northern Illinois (Calkins); Kankakee River (Ferriss); Quincy, Adams Co. (Garman); Du Page River (Gault); Hickory Creek, Will Co. (Handwerk); Quincy, Adams Co; Kappa, Woodford Co. (Hart); nearly all streams visited (Hinkley); Illinois River (Kelly); Mercer Co., Mississippi River (Marsh); Athens, Menard Co. (Nason); Spoon River, Thompson's Lake,

Fulton Co. (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co; Herod, Pope Co. (State Laboratory).

Lampsilis glans Lea.

Little Wabash River (Hinkley); BigVermilion River(Marsh); Southern Illinois (Ulffers).

Subgenus *Proptera* Rafinesque.

Lampsilis alata Say.

Savanna, Carroll Co.; Cook Co. (Baker); Northern Illinois; Fox River (Calkins); Fox River, Dundee, Kane Co. (Engleholm); Kankakee River (Ferriss, Handwerk); Shawneetown, Gallatin Co. (Fischer); Quincy, Adams Co. (Garman, Hart, Nason); Du Page River; Illinois River (Handwerk); Rock, Kishwaukee, Kaskaskia, Ohio, and Big Muddy rivers (Hinkley); La Salle Co. (Huett); Cook Co. (Jensen); Spoon River; Illinois River (Kelly, Strode); Mercer Co., Mississippi River (Marsh); Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Illinois River and Quiver Creek, Havana, Mason Co. (State Laboratory).

Lampsilis purpurata Lamarck.

Spring Creek (Handwerk).

Lampsilis gracilis Barnes.

Savanna, Carroll Co.; Cook Co. (Baker, Jensen); Northern Illinois (Calkins); Fox River, Dundee, Kane Co. (Engleholm); Kankakee River (Ferriss); Shawneetown, Gallatin Co. (Fischer); Mississippi River, Quincy, Adams Co. (Garman, Hart, Nason); Desplaines, Illinois, and Kankakee rivers (Handwerk); all rivers visited (Hinkley); La Salle Co. (Huett); Illinois River; Spoon River (Kelly, Strode); Mercer Co., Mississippi River (Marsh); Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co.; Cedar Lake, Lake Co.; Peoria, Peoria Co.; Dallas Slough, Dallas City, Hancock Co. (State Laboratory).

Lampsilis lævissima Lea (= *ohioensis* Say).

Northern Illinois (Calkins); Illinois River, Utica, La Salle Co. (Ferriss); Quincy, Adams Co. (Garman, Hart); Kaskaskia Ohio, and Wabash rivers (Hinkley); Spoon and Illinois rivers (Kelly, Strode); Mercer Co., Mississippi River (Marsh); South-

ern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Lampsilis leptodon Rafinesque (=*tenuissima* Lea).

Savanna, Carroll Co. (Baker); Illinois River (Ferriss); Kaskaskia River (Hinkley); Mississippi River, Mercer Co. (Marsh); Southern Illinois (Ulffers); Fulton Co. (Wolf).

Genus Obovaria Rafinesque.

Subgenus *Obovaria* Rafinesque.

Obovaria retusa Lamarck.

Northern Illinois (Calkins); Wabash River (Hinkley); La Salle Co. (Huett); Ohio River (Marsh); Spoon and Illinois rivers (Strode).

Obovaria circulus Lea.

Wabash River (Hinkley, Marsh); Southern Illinois (Ulffers).

Obovaria lens Lea.

Ohio River (Hinkley, Marsh).

Subgenus *Pseudoon* Simpson.

Obovaria ellipsis Lea.

Northern Illinois; Illinois River (Calkins); Kankakee River (Ferriss); Illinois River (Handwerk); Quincy, Adams Co. (Hart); Wabash and Ohio rivers (Hinkley); La Salle Co. (Huett); Mercer Co., Mississippi River (Marsh); Illinois and Spoon rivers (Strode); Fulton Co. (Wolf); Illinois River, Havana, Mason Co. (State Laboratory).*

Genus Plagiola (Rafinesque) Agassiz.

Subgenus *Plagiola* (Rafinesque) Agassiz.

Plagiola securis Lea.

Savanna, Carroll Co. (Baker); Northern Illinois (Calkins); Kankakee River (Ferriss, Handwerk); Shawneetown, Gallatin Co. (Fischer); Illinois River (Handwerk, Kelley, Nason, and Strode); Mississippi River, Quincy, Adams Co. (Hart); Kaskaskia, Wabash, and Ohio rivers (Hinkley); Mercer Co., Mississippi River (Marsh); Southern Illinois (Ulffers); Fulton Co. (Wolf); Illinois River, Havana, Mason Co. (State Laboratory).

*Calkins (Cin. Quart. Journ. Sci., I., p. 244) lists *ellipsis* as occurring near Chicago, but no authentic specimens have been seen, and occurrence of this species in the Chicago region is very doubtful.

Plagiola elegans Lea.

Savanna, Carroll Co. (Baker); Cook Co. (Baker, Calkins, Jensen); Chicago; Northern Illinois (Calkins); Kankakee River (Ferriss); Meredosia, Morgan Co. (Gault); Illinois River (Handwerk, Kelly, Strode); Mississippi River, Quincy, Adams Co. (Hart); Kaskaskia, Wabash, Little Wabash, Big Muddy, and Ohio rivers (Hinkley); La Salle Co. (Huett); Mercer Co., Mississippi River (Marsh); Athens, Menard Co.; Quincy, Adams Co. (Nason); Spoon River (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co.; Saline Co. (State Laboratory).

Plagiola donaciformis Lea (=*zigzag* Lea).

Cook Co. (Baker, Calkins); Northern Illinois (Calkins); Illinois River (Calkins, Handwerk, Kelly, Strode); Kankakee River; Spring Creek (Ferriss, Handwerk); Quincy, Adams Co. (Hart); Little Wabash, Kaskaskia, and Wabash rivers (Hinkley); La Salle Co. (Huett); Mercer Co., Mississippi River (Marsh); Athens, Menard Co. (Nason); Spoon River (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

DIGENÆ.

Genus Tritogonia Agassiz.

Tritogonia tuberculata Barnes.

Oregon, Ogle Co. (Baker); Northern Illinois (Calkins); Illinois River (Calkins, Handwerk); Fox River, Dundee, Kane Co. (Engleholm); Kankakee River (Ferriss); Shawneetown, Gallatin Co. (Fischer); Meredosia, Morgan Co. (Gault); Illinois River (Handwerk); Mississippi River, Quincy, Adams Co. (Hart); all rivers visited (Hinkley); La Salle Co. (Huett); Mercer Co., Mississippi River (Marsh); Athens, Menard Co.; Quincy, Adams Co. (Nason); Spoon River (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co.; Saline Co. (State Laboratory).*

*Calkins (Cin. Quart. Jour. Sci., I., p. 244) cites this species from Chicago, but no specimens have been seen. It is therefore a very doubtful inhabitant of the Chicago Area.

MESOGENÆ.

Genus Cyprogenia Agassiz.

Cyprogenia irrorata Lea (=*stegaria* Say).

Mt. Carmel, Wabash Co. (Calkins); Wabash River (Hinkley, Marsh); Southern Illinois (Ulffers).

Genus Obliquaria (Rafinesque) Simpson.

Obliquaria reflexa Rafinesque (=*cornuta* Barnes).

Savanna, Carroll Co. (Baker); Cook Co. (Baker, Calkins); Northern Illinois; Mt. Carmel, Wabash Co. (Calkins); Kankakee River (Ferriss, Handwerk); Shawneetown, Gallatin Co. (Fischer); Meredosia, Morgan Co. (Gault); Illinois River (Handwerk, Kelly, Ferriss, Strode); Mississippi River, Quincy, Adams Co. (Hart); Little Wabash, Big Muddy, and Ohio rivers (Hinkley); La Salle Co. (Huett); Mercer Co., Mississippi River (Marsh); Athens, Menard Co; Mississippi River, Quincy, Adams Co. (Nason); Spoon River (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

PTYCHOGENÆ.

Genus Ptychobranchus Simpson.

Ptychobranchus phaseolus Hildreth.

Wabash River (Hinkley, Marsh); Southern Illinois (Ulffers).

ESCHATIGENÆ.

Genus Dromus Simpson.

Dromus dromus Lea.

Ohio River (Marsh).

DIAGENÆ.

Genus Strophitus Rafinesque.

Strophitus edentulus Say (=*shafferiana* Lea, *wardiana* Lea).

Oregon, Ogle Co.; Savanna, Carroll Co. (Baker); Cook Co. (Baker, Higley, Jensen, Lyon); Northern Illinois (Calkins); Peoria, Peoria Co. (Chamberlain); Hickory Creek, Will Co. (Ferriss, Handwerk); Du Page River (Gault); Desplaines River (Handwerk); Rockford, Winnebago Co.; Kaskaskia and Wabash rivers (Hinkley); La Salle Co. (Huett); Illinois River (Kelly, Nason); Mercer Co.; Mississippi and Wabash rivers (Marsh); Fox River, Dundee, Kane Co., and Algonquin,

McHenry Co; Athens, Menard Co. (Nason); Spoon River (Strode); Fulton Co. (Wolf); Havana, Mason Co.; Peoria, Peoria Co. (State Laboratory).

Strophitus edentulus pavonius Lea.

Cook Co. (Baker); Hickory Creek, Will Co. (Ferriss); Joliet, Will Co. (Handwerk); Wabash River (Marsh).

HOMOGENÆ.

Genus ANODONTA (Bruguiére) Lamarck.

Anodonta imbecilis Say.

Cook Co. (Baker, Calkins, Jensen); Northern Illinois (Calkins); Illinois River (Calkins, Kelly, Strode); Kankakee River (Ferriss); Quincy, Adams Co. (Garman, Hart); Desplaines River (Handwerk); Kishwaukee and Big and Little Muddy rivers (Hinkley); La Salle Co. (Huett); Pulaski Co. (Lyon); Mercer Co., Mississippi River (Marsh); Spoon River (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Quiver Lake and Havana, Mason Co.; Peoria, Peoria Co.; Hamilton Co.; Pekin Lake, Tazewell Co. (State Laboratory).

Anodonta suborbiculata Say.

Northern Illinois (Calkins); Springfield, Sangamon Co. (Call); Putnam Co. (Ferriss); Thompson's Lake, Fulton Co. (Kelly, Strode); Fulton Co. (Lyon, Wolf); Mercer Co., Mississippi River (Marsh); Spoon and Illinois rivers (Strode); Southern Illinois (Ulffers); Thompson's Lake, Fulton Co.; Clear and Quiver lakes, Mason Co. (State Laboratory).

Anodonta grandis Say (=*salmonia* Lea, *ovata* Lea).

Cook Co. (Baker, Nason); Northern Illinois (Calkins); Fox River, Dundee, Kane Co. (Engleholm); Illinois River (Ferriss, Strode); Quincy, Adams Co. (Garman, Hart, Nason); Du Page River (Gault); Desplaines River (Handwerk); Mackinaw River, Kappa, Woodford Co. (Hart); Winnebago Co.; Little Wabash, Kaskaskia, Big Muddy, and Little Muddy rivers (Hinkley); La Salle Co. (Huett); Thompson's Lake and Spoon River, Fulton Co. (Kelly, Strode); Union Co. (Lyon); Lake Co. (Marcy); Rock River, Mercer Co.; Washington Co.; Winnebago Co. (Marsh); Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Grass Lake, Lake Co. (Woodruff); Havana, Mason Co.; Crystal

Lake, Urbana, Champaign Co.; Fox Lake, Lake Co.; Thompson's Lake, Fulton Co.; Hamilton Co. (State Laboratory).

Anodonta grandis footiana Lea (=*marryattana* Lea).

Cook Co. (Baker, Calkins, Marsh); Dundee, Kane Co. (Engleholm); Du Page River (Handwerk); Silver and Crystal lakes and Algonquin, McHenry Co. (Lyon, Nason); Lake Co. (Marcy, Marsh); Northern Illinois (Nason); Grass Lake, Lake Co. (Woodruff); Cedar Lake, Lake Co. (State Laboratory).

Anodonta grandis gigantea Lea (=*decora* Lea, *plana* Lea).

Cook Co. (Calkins); Mercer Co., Edwards Creek; Big Vermilion River (Marsh); Spoon River (Strode); Southern Illinois (Ulffers).

Anodonta corpulenta Cooper.

Savanna, Carroll Co. (Baker); Northern Illinois; Peoria Lake, Peoria Co.; La Salle Co. (Calkins); Aledo, Mercer Co. (Call); Illinois River (Cooper, Ferriss, Handwerk, Kelly); Quincy, Adams Co. (Hart, Nason); La Salle Co. (Huett); Cook Co. (Jensen); Thompson's Lake, Fulton Co. (Kelly, Strode); Mercer Co., Mississippi River (Marsh); Fulton Co. (Wolf); Havana, Mason Co; Pekin Lake, Tazewell Co. (State Laboratory).

Anodonta marginata Say (=*fragilis* Lamarck, *subcarinata* Currier, *lacustris* Lea).

Hickory Creek, Will Co.; Desplaines River (Handwerk); Lake Co. (Marsh); Spoon River (Strode); Fulton Co. (Wolf).

Simpson gives this as found in the St. Lawrence River drainage, but the records above seem to be authentic.

Anodonta implicata Say.

Lake Co. (Marsh).

Genus LASTENA Rafinesque.

Lastena lata Rafinesque (=*dehiscens* Say).

Illinois (Call); Illinois River (Marsh); Southern Illinois (Ulffers).

Genus ANODONTOIDES Simpson.

Anodontoides ferussacianus Lea.

Cook Co. (Baker); Hickory Creek, Will Co. (Ferriss, Handwerk); Du Page River (Gault); Kishwaukee River and Kent's Creek (Hinkley); Mercer Co., Edwards Creek (Marsh); Fox

River, Dundee, Kane Co. (Nason); Spoon River (Strode); Cedar Lake, Lake Co. (State Laboratory).

Anodontoides ferussacianus subcylindraceus Lea.

Cook Co. (Baker, Jensen): Northern Illinois (Calkins); Hickory Creek, Will Co. (Ferriss, Handwerk); Du Page Co. (Lyon); Lake Co. (Marcy); Peoria, Peoria Co. (State Laboratory).

Genus Arcidens Simpson.

Arcidens confragosus Say.

Savanna, Carroll Co. (Baker); Northern Illinois (Calkins); Springfield, Sangamon Co., and Fox River (Call); Illinois River, Utica, La Salle Co. (Ferriss, Handwerk); Mississippi River, Quincy, Adams Co. (Hart, Nason); Kaskaskia, Big Muddy, and Little Wabash rivers (Hinkley); La Salle Co. (Huett); Spoon and Illinois rivers (Kelly, Strode); Mercer Co., Mississippi River (Marsh); Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Lake Michigan, Chicago, Cook Co.; Havana, Mason Co. (State Laboratory).

Genus Symphynota Lea.

Subgenus *Symphynota* Lea.*

Symphynota compressa Lea (=*pressa* Lea).

Cook Co. (Baker); Hickory Creek, Will Co. (Ferriss); Du Page River (Gault); Illinois River (Handwerk); Kent's Creek, Rockford, Winnebago Co. (Hinkley); Mercer Co. (Marsh); Mill Race, Algonquin, McHenry Co. (Nason).

Subgenus *Lasmigona* Rafinesque.

Symphynota costata Rafinesque (=*rugosa* Barnes).

Savanna, Carroll Co. (Baker): Cook Co. (Baker, Jensen); Northern Illinois: Fox River (Calkins): Fox River, Dundee, Kane Co. (Engleholm, Nason); Hickory Creek, Will Co. (Ferriss); Du Page and Kankakee rivers (Handwerk); Illinois River (Handwerk, Strode): Mackinaw River, Kappa, Woodford Co. (Hart); Winnebago Co. (Hinkley); La Salle Co. (Huett); Spoon River (Kelly, Strode): Mercer Co., Mississippi River

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**Symphynota neglecta* Lea is reported from Fulton Co. by Wolf (Am. Journ. Conch., VI., p. 29), but the record must rest upon a misidentification, as this species is confined to northern Alabama. (*Vide* Simpson, Synopsis, p. 664.)

(Marsh); Fox River, Algonquin, McHenry Co; Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Subgenus *Pterosygna* Rafinesque.

Symphynota complanata Barnes.

Savanna, Carroll Co. (Baker); Cook Co. (Baker, Calkins, Jensen); Northern Illinois (Calkins); Peoria, Peoria Co. (Chamberlain); Mazon Creek, Grundy Co. (Dilg); Hickory Creek, Will Co. (Ferriss, Handwerk); Starved Rock, La Salle Co. Illinois River (Handwerk); Kappa, Woodford Co. (Hart); Mississippi River, Quincy, Adams Co. (Hart, Nason); Winnebago Co.; Kaskaskia, Big Muddy, and Little Wabash rivers (Hinkley); Spoon River; Illinois River (Kelly, Strode); Mercer Co., Mississippi River (Marsh); Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Genus Alasmidonta Say.

Subgenus *Pressodonta* Simpson.*

Alasmidonta calceola Lea (= *deltoidea* Lea).

Cook Co. (Baker, Jensen, Lyon); Northern Illinois (Calkins); Hickory Creek, Joliet, Will Co. (Ferriss, Handwerk); Mackinaw River, Kappa, Woodford Co. (Hart); Kishwaukee River and Kent's Creek (Hinkley); La Salle Co. (Huett); Mercer Co., Edwards Creek, Wabash River (Marsh); Algonquin, McHenry Co; Athens, Menard Co. (Nason); Spoon River (Strode); Fulton Co. (Wolf).

Subgenus *Rugifera* Simpson.

Alasmidonta marginata Say.

Cook Co. (Baker, Higley); Northern Illinois; Fox River (Calkins); Hickory Creek, Will Co. (Ferriss, Handwerk); Illinois River (Handwerk); Mackinaw River, Kappa, Woodford Co. (Hart); Winnebago Co. (Hinkley); Mercer Co., Mississippi River (Marsh); Athens, Menard Co. (Nason); Fox River, Dundee, Kane Co. (Nason, Swick); Spoon River (Strode); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

***Alasmidonta heterodon* Lea is reported from Southern Illinois by Ulffers. As this species is confined to the Atlantic states from Maine to Virginia, this reference must rest upon a misidentification.

Genus Hemilastena (Agassiz) Simpson.

Hemilastena ambigua Say (= *hildrethiana* Lea).

Cook Co. (Baker): Kankakee River, Wilmington, Will Co. (Ferriss, Handwerk); Hickory Creek, Will Co. (Handwerk); Wabash River; Mercer Co. (Marsh); Spoon River (Strode).

Genus Margaritana Schumacher.

Margaritana margaritifera Linné.

Illinois River (Calkins).

Margaritana monodonta Say (= *soleniformis* Lea).

Northern Illinois (Calkins); Mercer Co. (Call, Marsh); Kankakee River (Ferriss, Handwerk); Mississippi River, Quincy, Adams Co. (Hart); Mississippi River (Marsh); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Genus Unio Retzius.*

Section *Elliptio* Rafinesque.

Unio gibbosus Barnes (= *arctior* Lea).

Oregon, Ogle Co.; Savanna, Carroll Co. (Baker); Cook Co. (Baker, Calkins, Higley, Nason); Northern Illinois (Calkins); Kankakee River (Ferriss, Handwerk); Illinois and Du Page rivers (Handwerk); Mississippi River, Quincy, Adams Co. (Hart); Winnebago Co.; Wabash and Ohio rivers (Hinkley); La Salle Co. (Huett); Mercer Co.; Mississippi and Wabash rivers (Marsh); Fox River, Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Fox River, Dundee, Kane

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**Unio inflatus* Lea (= *Lampsilis alabamensis* Conrad) is reported by Wolf from Fulton Co. (Am. Journ. Conch., VI., p. 29). This record is erroneous, as the species is confined to the Alabama and Tombigbee rivers.

Unio bullatus Rafinesque is reported by Ulffers from Southern Illinois. I do not know what species this is intended for. Rafinesque described an *Obliquaria bullata*, but it is absolutely indeterminate.

Unio torsus Rafinesque reported by Ulffers from Southern Illinois, is indeterminable.

Unio niger Conrad is reported from Southern Illinois by Ulffers. I know of no species of that name. *Unio mytiloides* Rafinesque is also an indeterminable species. (Ulffers, p. 610.)

Unio scalenius Rafinesque is reported from Southern Illinois by Ulffers. There is no *scalenius* of Rafinesque, and *scalenius* Say = *Pleurobema decisa* Lea, which is confined to the Alabama and Tombigbee river systems.

Unio rubidundus Say is reported by Ulffers from Southern Illinois. There is no *rubidundus* or *rubicundus* described by Say.

Co. (Nason, Swick); Spoon and Illinois rivers (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Unio gibbosus delicatus Simpson.

Cook Co. (Baker); Kent's Creek (Hinkley); Dundee, Kane Co. (Swick).

Unio crassidens Lea.

Savanna, Carroll Co. (Baker); Northern Illinois (Calkins); Illinois River, Utica, La Salle Co. (Ferriss); Kaskaskia and Wabash rivers (Hinkley); La Salle Co. (Huett); Mercer Co., Mississippi River (Marsh); Mt Carmel, Wabash Co. (Nelson); Spoon River (Strode); Fulton Co. (Wolf).

Section *Uniomerus* Conrad.

Unio tetralasmus Say (=*jamesianus* Lea).

Washington and Perry counties, in creeks and ponds (Hinkley); Big Muddy River (Marsh); Phelps Lake, Fulton Co.; Sidney and Urbana, Champaign Co. (State Laboratory).

Unio tetralasmus camptodon Say.

Du Bois, Washington Co., in pond (Hinkley); Albion, Edwards Co. (Jensen).

Genus PLEUROBEMA (Rafinesque) Agassiz.*

Pleurobema clava Lamarck.

Wabash River (Hinkley, Marsh).

Section *Plethobasus* Simpson.

Pleurobema æsopus Green.

Savanna, Carroll Co. (Baker); Northern Illinois (Calkins); Fox River, Dundee, Kane Co. (Connor); Kankakee River (Ferriss, Handwerk); Mississippi River, Quincy, Adams Co. (Hart); Green, Kaskaskia, Wabash, and Rock rivers (Hinkley); La Salle Co. (Huett); Mercer Co., Mississippi River (Marsh); Athens, Menard Co. (Nason); Mt. Carmel, Wabash Co. (Nelson); Spoon River (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Illinois River, Havana, Mason Co. (State Laboratory).

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* *Pleurobema cor* Conrad is reported from Southern Illinois by Ulffers,—a misidentification, as the species is confined to the Alabama River system of Alabama and the Flint River of Georgia.

Pleurobema cicatricosa Say (= *varicosa* Say).
Ohio River (Marsh); Southern Illinois (Ulffers).

TETRAGENEÆ.

Genus Quadrula (Rafinesque) Agassiz.

Section *Crenodonta* Schlüter.

Quadrula plicata Say.
Cook Co.; Savanna, Carroll Co. (Baker); Northern Illinois (Calkins); Kankakee River (Ferriss, Handwerk); Desplaines River (Handwerk); Illinois River (Handwerk, Kelly, Strode); Quincy, Adams Co. (Hart); all rivers visited (Hinkley); La Salle Co. (Huett); Spoon River (Kelly, Strode); Mississippi River, Mercer Co. (Marsh); Quincy, Adams Co.; Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Quadrula undulata Barnes.
Oregon, Ogle Co.; Cook Co. (Baker); Savanna, Carroll Co. (Baker, Jensen); Northern Illinois; Vermilion and Illinois rivers (Calkins, Handwerk); Peoria, Peoria Co. (Chamberlain); Kankakee River (Ferriss, Handwerk); Starved Rock, La Salle Co. (Handwerk); Mackinaw River, Kappa, Woodford Co. (Hart); Winnebago Co.; Big Muddy, Little Muddy, and Saline rivers (Hinkley); La Salle Co. (Huett); Desplaines River (Lyon); Mercer Co., Edwards Creek (Marsh); Fox River, Algonquin, McHenry Co. (Nason); Fox River, Dundee, Kane Co. (Nason, Swick); Spoon River (Strode); Fulton Co. (Wolf).

Quadrula heros Say (= *multiplicata* Lea).
Savanna, Carroll Co. (Baker); Northern Illinois (Calkins); Illinois River (Calkins, Handwerk, Kelly, Strode); Utica, La Salle Co., in canal (Ferriss); Ottawa, La Salle Co. (Handwerk); Mississippi River, Quincy, Adams Co. (Hart, Nason); Kaskaskia, Wabash, Little Wabash, and Big Muddy rivers (Hinkley); La Salle Co. (Huett); Spoon River (Kelly, Strode); Drury Creek (Lyon); Mercer Co., Mississippi River (Marsh); Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Quadrula trapezoides Lea (= *interruptus* Say).
Southern Illinois (Ulffers). This is a doubtful record and should be substantiated.

Section *Quadrula* (Rafinesque) Agassiz.

Quadrula cylindrica Say.

Shawneetown, Gallatin Co. (Fischer); Ohio River, Golconda, Pope Co. (Hart); Wabash River (Hinkley); Little Vermilion River (Marsh); Mt. Carmel, Wabash Co. (Nelson); Southern Illinois (Ulffers).

Quadrula metanevra Rafinesque.

Savanna, Carroll Co. (Baker); Northern Illinois (Calkins); Illinois River (Calkins, Handwerk, Kelly); Kankakee River (Ferriss, Handwerk); Quincy, Adams Co. (Hart, Nason); Kaskaskia, Wabash, and Ohio rivers (Hinkley); La Salle Co. (Huett); Mercer Co., Mississippi River (Marsh); Athens, Menard Co. (Nason); Spoon River (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Quadrula metanevra wardii Lea.

Illinois River (Handwerk, Marsh).

Section *Theliderma* (Swainson) Simpson.

Quadrula lachrymosa Lea (= *quadrula* Say, *asperimus* Lea).

Savanna, Carroll Co. (Baker); Cook Co. (Baker, Jensen); Kankakee River (Ferriss, Handwerk); Shawneetown, Gallatin Co. (Fischer); Illinois River (Handwerk, Strode); Quincy, Adams Co. (Hart, Nason); Kaskaskia, Big Muddy, Little Wabash, Ohio, and Pecatonica rivers (Hinkley); Spoon River (Kelly, Strode); Mississippi River, Mercer Co. (Marsh); Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co.; Peoria, Peoria Co. (State Laboratory).

Quadrula lachrymosa lunulata Pratt.

Mississippi River (Marsh).

Quadrula fragosa Conrad.

Illinois River (Ferriss, Marsh); Kaskaskia River (Hinkley); Athens, Menard Co. (Nason); Spoon River (Strode); Fulton Co. (Wolf).

Quadrula pustulosa Lea (= *dorfeuilliana* Lea, *schoolcraftensis* Lea).

Oregon, Ogle Co.; Savanna, Carroll Co. (Baker); Cook Co. (Baker, Calkins, Jensen); Northern Illinois; Rock River (Calkins); Kane Co. (Connor); La Salle Co. (Derr, Huett); Kankakee River (Ferriss, Handwerk); Illinois River (Handwerk);

Mississippi River, Quincy, Adams Co. (Hart); all rivers visited (Hinkley); Spoon River; Illinois River (Kelly, Strode); Mercer Co., Edwards Creek; Mississippi and Illinois rivers (Marsh); Fox River, Algonquin, McHenry Co.; Quincy. Adams Co.; Athens, Menard Co. (Nason); Mt. Carmel, Wabash Co. (Nelson); Fulton Co. (Wolf); Meredosia, Morgan Co. (Woodruff); Havana, Mason Co. (State Laboratory).

Quadrula pustulata Lea.

Savanna, Carroll Co. (Baker); Northern Illinois (Calkins); Utica, La Salle Co. (Ferriss); Shawneetown, Gallatin Co. (Fischer); Kaskaskia, Wabash, and Ohio rivers (Hinkley); Mississippi River, Quincy, Adams Co. (Hart); La Salle Co. (Huett); Illinois and Spoon rivers (Kelly, Strode); Mississippi River, Mercer Co. (Marsh); Athens, Menard Co. (Nason); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Reported from Chicago by Calkins, but no specimens have been seen from this area.

Quadrula cooperiana Lea.

Wabash River (Hinkley); Ohio River (Marsh); Fulton Co. (Wolf).

Quadrula rubiginosa Lea (= *flava* Conrad).

Cook Co. (Baker, Calkins, Jensen, Lyon); Northern Illinois; Illinois River (Calkins); Kankakee River (Ferriss, Handwerk); Mackinaw River, Kappa, Woodford Co. (Hart); Kishwaukee, Rock, and Pecatonica rivers (Hinkley); La Salle Co. (Huett); Spoon River (Kelly, Strode); Mercer Co., Edwards Creek; Kankakee River (Marsh); Algonquin, McHenry Co. (Nason); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Quadrula trigona Lea.

Oregon, Ogle Co; Savanna, Carroll Co. (Baker); Cook Co. (Baker, Derr, Jensen); Northern Illinois (Calkins); Kane Co. (Engleholm); Kankakee River (Ferriss, Handwerk); Quincy, Adams Co. (Hart, Nason); all rivers visited (Hinkley); La Salle Co. (Huett); Illinois and Spoon rivers (Kelly, Strode); Mercer Co., Mississippi River (Marsh); Athens, Menard Co. (Nason); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Quadrula obliqua Lamarck.

Savanna, Carroll Co. (Baker); Northern Illinois and Missis-

sippi River (Calkins); Wabash and Ohio rivers (Hinkley); La Salle Co. (Huett); Ohio River (Marsh); Spoon and Illinois rivers (Strode).

Quadrula coccinea Conrad (= *catillus* Conrad).

Cook Co. (Baker, Jensen); Northern Illinois (Calkins); Fox and Du Page rivers (Ferriss); Illinois, Du Page, and Kankakee rivers and Lilycash Creek, Will Co. (Handwerk); Kishwaukee, Rock, and Pecatonica rivers (Hinkley); La Salle Co. (Huett); Mercer Co., Illinois River (Marsh); Fox River, Dundee, Kane Co.; Algonquin, McHenry Co. (Nason); Mt. Carmel, Wabash Co. (Nelson); Spoon River (Strode); Fulton Co. (Wolf).

Quadrula solida Lea (= *fulgidus* Lea).

Northern Illinois (Calkins); Illinois River (Calkins, Handwerk, Strode); Kankakee River (Ferriss, Handwerk, Marsh); Kishwaukee and Pecatonica rivers (Hinkley); La Salle Co. (Huett); Mercer Co., Mississippi River (Marsh); Quincy, Adams Co. (Nason); Spoon River (Strode); Fulton Co. (Wolf); Milan, Rock Island Co. (State Laboratory).

Quadrula plena Lea.

Wabash River (Hinkley, Marsh).

Quadrula pyramidata Lea.

Little Wabash River (Hinkley); Ohio River (Marsh); Athens, Menard Co. (Nason); Spoon and Illinois rivers (Strode); Southern Illinois (Ulffers).

Quadrula subrotunda Lea.

Illinois River (Call); Ohio River (Marsh).

Quadrula ebena Lea.

Oregon, Ogle Co; Savanna, Carroll Co. (Baker); Northern Illinois (Calkins); Moline, Rock Island Co. (Call); Illinois River, Utica, La Salle Co. (Ferriss, Handwerk); Shawneetown, Gallatin Co. (Fischer); Quincy, Adams Co. (Hart, Nason); Ohio, Wabash, and Little Wabash rivers (Hinkley); La Salle Co. (Huett); Illinois and Spoon rivers (Kelly, Strode); Mercer Co., Mississippi River (Marsh); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Subgenus *Rotundaria* (Rafinesque) Simpson.

Quadrula tuberculata Rafinesque (= *verrucosa* Barnes).

Savanna, Carroll Co. (Baker); Cook Co. (Baker, Calkins,

Higley); Northern Illinois (Calkins); Illinois River (Calkins, Handwerk, Marsh, Strode); Kane Co. (Engleholm); Kankakee River (Ferriss, Handwerk); Mississippi River, Quincy, Adams Co. (Hart); La Salle Co. (Huett); Spoon River (Kelly, Strode); Rock River (Kelly, Wiswall); Athens, Menard Co. (Nason); Southern Illinois (Ulffers).

Quadrula granifera Lea.

Oregon, Ogle Co. (Baker); Mercer Co. (Ferriss, Marsh); Wabash and Little Wabash rivers (Hinkley); Rock River (Hinkley, Wiswall); Illinois River (Kelly); Mississippi River (Marsh); Spoon River (Strode); Desplaines River, Cook Co. (Zetek); Havana, Mason Co. (State Laboratory).

Order TELEODESMACEA.

Superfamily Cyrenacea.

Family SPHÆRIIDÆ.

Genus Sphærium Scopoli.*

Sphærium vermontanum Prime.

Cook Co. (Baker, Lyon); Hickory Creek, Will Co. (Ferriss); Canton, Fulton Co. (Nason); Lake Michigan, Chicago, Cook Co. (State Laboratory).

Sphærium solidulum Prime.

Quincy, Adams Co. (Garman); Hardin Co. (Hinkley); Mercer Co.; White Co. (Marsh); Fulton Co. (Wolf); Lake Michigan, Chicago, Cook Co. (State Laboratory).

Sphærium stamineum Conrad.

Cook Co. (Baker, Calkins, Jensen); Hickory Creek, Will Co.; Kankakee Feeder (Ferriss); Du Page Co. (Gault); Lilycash Creek, Will Co. (Handwerk); Quincy, Adams Co.; Kappa, Woodford Co. (Hart); Winnebago Co.; Big Muddy, Little Wabash, Ohio, and Saline rivers (Hinkley); McLean Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Canton, Fulton Co. (Nason); Matanzas and Quiver lakes, Havana, Mason Co.; Quincy, Adams Co.; Clay Co.; Homer and Urbana, Champaign Co.; Thompson's Lake, Fulton Co.; Peoria, Peoria Co.; Cedar, Fox,

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**Sphærium triangulare* Say is reported from Fulton Co. by Wolf, but this is an error of identification, as *triangulare* is a Mexican species.

and Pistakee lakes, Lake Co.; Lake Michigan, Chicago, Cook Co.; Milan, Rock Island Co. (State Laboratory).

Sphærium stamineum forbesi Baker.

Thompson's Lake, Fulton Co.; Matanzas Lake, Havana, Mason Co.; Little Fox River, White Co. (State Laboratory).

Sphærium striatinum Lamarck.

Cook Co. (Baker, Calkins, Higley, Nason); Joliet, Will Co. (Baker, Ferriss, Handwerk); Northern Illinois (Calkins); Stark Co. (Chase); Hickory Creek, Will Co. (Ferriss); Lilycash Creek, Will Co. (Handwerk); Quincy, Adams Co.; Kappa, Woodford Co. (Hart); Winnebago Co.; Big Muddy, Little Muddy, Wabash, and Ohio rivers, (Hinkley); La Salle Co. (Huett); Union Co. (Lyon); Mercer Co.; McLean Co. (Marsh); Illinois River and Quiver Lake, Havana, Mason Co.; Milan, Rock Island Co.; Urbana, Champaign Co.; Panola, Woodford Co.; Fulton Co.; Grand Pierre Creek, Herod, Pope Co.; Peoria, Peoria Co.; Long and Cedar lakes, Lake Co.; Chicago, Lake Michigan, Cook Co.; Kickapoo Creek, Coles Co.; Swanwick Creek, Perry Co.; Henderson Creek, Biggsville, Henderson Co. (State Laboratory).

Sphærium simile Say (= *sulcatum* Lamarck).

Cook Co. (Baker, Calkins); Northern Illinois (Calkins); Kankakee River (Ferriss); Lilycash Creek, Will Co. (Handwerk); Winnebago Co. (Hinkley); La Salle Co. (Huett); Mercer, McLean, and Edgar counties (Marsh); Elmhurst, Du Page Co.; Elgin, Kane Co.; Algonquin, McHenry Co.; Rock River (Nason); Southern Illinois (Ulffers); Sand, Clear, Fox, Pistakee, and Cedar lakes, Lake Co.; Lake Michigan, Chicago, Lake Co.; Warsaw, Hancock Co. (State Laboratory).

Sphærium lilycashense Baker.

Lilycash Creek, Joliet, Will Co. (Baker, Ferriss, Handwerk).

Sphærium fabale Prime.

Cook Co. (Baker, State Laboratory); Kankakee Feeder (Ferriss); Illinois (Prime).

Sphærium occidentale Prime.

Cook Co. (Baker, Higley, Jensen); Northern Illinois (Calkins); Joliet, Will Co. (Ferriss, Handwerk); Winnebago Co. and Little Muddy Creek (Hinkley); La Salle Co. (Huett); Bush Park, Mercer Co. (Marsh); Fulton Co. (Wolf); Pistakee Lake, Lake Co. (State Laboratory).

Sphærium rhomboideum Prime.

Winnebago Co. (Hinkley, Marsh); Athens, Menard Co. (Nason); Sand and Fourth lakes, Lake Co. (State Laboratory).

Genus MUSCULIUM Link, 1807.

(= *Calyculina* Clessin, 1872.)

Musculium transversum Say.

Cook Co. (Baker, Calkins); Northern Illinois (Calkins); Hickory Creek, Will Co. (Ferriss); Joliet, Will Co. (Ferriss, Handwerk); Quincy, Adams Co. (Garman, Hart); Desplaines River (Handwerk); Winnebago Co.; Big and Little Muddy, Wabash, Ohio, and Saline rivers (Hinkley); Mercer Co. (Marsh); Athens, Menard Co. (Nason); Fulton Co. (Wolf); Spring Bay, Peoria, Peoria Co.; Quiver and Matanzas lakes, and Illinois River, Havana, Mason Co.; Thompson's Lake, Fulton Co.; Sidney and Urbana, Champaign Co.; Bernadotte, Spoon River, Fulton Co.; Pekin Lake, Tazewell Co.; Quincy, Adams Co. (State Laboratory).

Musculium truncatum Linsley.

Cook Co. (Baker, Jensen); Joliet, Desplaines River, Will Co. (Ferriss, Handwerk); Kappa, Woodford Co. (Hart); Mercer Co. (Marsh); Athens, Menard Co.; Canton, Fulton Co. (Nason); Quincy, Adams Co. (Oakes); Urbana, Champaign Co.; Fox, Cedar, and Clear lakes, Lake Co.; Phelps Lake, Fulton Co.; Havana and Quiver Lake, Mason Co. (State Laboratory).

Musculium partumeium Say.

Cook Co. (Baker, Calkins); Northern Illinois (Calkins); Rock Run, Joliet, Will Co. (Ferriss); La Salle Co. (Huett); Crystal Lake, McHenry Co. (Lyon); Eastern Illinois (Marsh); Athens, Menard Co. (Nason); Du Page Co. (Woodruff); Illinois River, Havana, Mason Co.; Cedar Lake, Lake Co.; ditch, Urbana, Champaign Co. (State Laboratory).

Musculium hodgsoni Sterki.

Albion, Edwards Co. (Sterki).

Musculium elevatum Haldeman.

Big Muddy River (Hinkley). This species is typically of southern distribution (Florida and Alabama), and the present record extends its range considerably to the north.

Musculium sphæricum Anthony.

Mississippi River (Marsh); Canton, Fulton Co. (Nason); Fulton Co. (Wolf).

Musculium secure Prime.

Rock Run, Joliet, Will Co.(Ferriss); Cook Co. (Jensen); Sand and Cedar lakes, Lake Co. (State Laboratory).

Musculium rosaceum Prime.

Fulton Co. (Wolf). A somewhat doubtful record, as this species is an eastern one.

Musculium jayanum Prime (=*jayensis* Prime).

Winnebago Co. (Hinkley); Mercer Co. (Marsh); Havana, Mason Co. (State Laboratory).

Genus Corneocyclas Ferussac, 1818.

(= *Pisidium* Pfeiffer, 1824.)

Corneocyclas abdita Haldeman.

Cook Co. (Baker, Calkins, Higley, Nason); Northern Illinois (Calkins); Kankakee River (Ferriss); Joliet, Will Co. (Ferriss, Handwerk); Lilycash Creek, Will Co. (Handwerk); Winnebago Co. (Hinkley, Marsh); La Salle Co. (Huett); Canton, Fulton Co. (Nason); Quiver and Matanzas lakes, and Illinois River, Havana, Mason Co.; Pistakee, Sand, and Cedar lakes, Lake Co.; Thompson's Lake, Fulton Co.; Grand Pierre Creek, Herod, Pope Co.; Lake Michigan, Cook Co. (State Laboratory).

Corneocyclas abyssorum (Stimpson) Sterki.

Off Racine, Wisconsin, in deep water, dredged by George L. Marston (Hoy, Sterki).

As this species probably inhabits that part of Lake Michigan bordering on Illinois, it is included in this list.

Corneocyclas æquilateralis Prime.

Mercer Co. (Marsh); Havana, Mason Co.; Thompson's Lake, Fulton Co. (State Laboratory).

Corneocyclas affinis Sterki.

Winnebago Co. (Hinkley); Illinois (Sterki).

Corneocyclas compressa Prime.

Cook Co. (Baker, Calkins, Higley, Jensen); Northern Illinois (Calkins); Joliet, Will Co. (Ferriss, Handwerk); Lilycash Creek, Will Co. (Handwerk); Winnebago Co. and Big Muddy River, (Hinkley); La Salle Co. (Huett); Mercer Co. (Marsh); Canton,

Fulton Co. (Nason): Matanzas and Quiver lakes, and Illinois River, Havana, Mason Co.: Pistakee, Cedar, Fourth, Loon, Fox, and Sand lakes, Lake Co.; Lake Michigan, Cook Co.; Thompson's Lake, Fulton Co.: Quincy, Adams Co.; Grand Pierre Creek, Herod, Pope Co.; Towanda, McLean Co (State Laboratory).

Corneocyclas compressa lævigata Sterki.

Cedar and Fox lakes and between Loon and Cedar lakes, Lake Co. (State Laboratory).

Corneocyclas compressa rostrata Sterki.

Lake Michigan, Cook Co. (State Laboratory).

Several specimens are provisionally referred to this variety by Dr. Sterki.

Corneocyclas cruciata Sterki.

Lilycash Creek, Will Co. (Handwerk); Joliet, Will Co. (Handwerk, Sterki).

Corneocyclas fallax Sterki.

Lilycash Creek, Joliet, Will Co. (Ferriss, Handwerk).

Corneocyclas handwerki Sterki.

Lilycash Creek, Will Co. (Handwerk).

Corneocyclas idahoensis Roper.

Lake Michigan, Cook Co. (Daniels).

Corneocyclas pauperculata crystalensis Sterki.

Sand Lake, Lake Co. (State Laboratory).

Corneocyclas mediana Sterki.

Pistakee Lake, Lake Co. (State Laboratory).

Corneocyclas tenuissima Sterki.

Long Lake, Lake Co. (State Laboratory).

Corneocyclas kirklandi Sterki.

Cook Co. (Baker).

Corneocyclas noveboracensis Prime.

Northern Illinois (Marsh); Cedar and Pistakee lakes, Lake Co. (State Laboratory).

Corneocyclas noveboracensis elevata Sterki.

Joliet, Will Co. (Ferriss, Handwerk).

Corneocyclas peralata Sterki.

Elizabethtown, Hardin Co. (Hinkley): Havana, Mason Co. (Sterki): Fox Lake, Lake Co.: Lake Michigan, Cook Co. (State Laboratory).

Corneocyclas polita Sterki.

Joliet, Will Co. (Handwerk); Illinois River, Havana, Mason Co. (State Laboratory).

Corneocyclas punctata Sterki.

Lilycash Creek, Will Co. (Handwerk).

Corneocyclas punctata simplex Sterki.

Joliet, Will Co. (Ferriss, Handwerk).

Corneocyclas roperi Sterki.

Joliet, Will Co. (Handwerk, Sterki).

Corneocyclas rotundata Prime.

Northern Illinois (Marsh).

Corneocyclas sargenti Sterki.

Illinois (Sterki); Cedar Lake, Lake Co. (State Laboratory).

Corneocyclas scutellata Sterki.

Lake Michigan, near Chicago, Cook Co. (Baker); Huntley, McHenry Co. (Ferriss); Joliet, Will Co. (Handwerk); Fox and Pistakee lakes, Lake Co.; Lake Michigan, Cook Co. (State Laboratory).

Corneocyclas splendidula Sterki.

Lilycash Creek, Will Co. (Handwerk); Sand and Cedar lakes, Lake Co. (State Laboratory).

Corneocyclas variabilis Prime.

Lake Michigan, Cook Co. (Baker); Cook Co. (Baker, Jensen); Kankakee River (Ferriss); Du Page River (Gault); Lilycash Creek, Joliet, Will Co. (Handwerk); Winnebago Co. (Hinkley); Mercer Co. (Marsh); Canton, Fulton Co. (Nason); Fulton Co. (Wolf); Pistakee, Sand, Cedar, and Fox lakes, Lake Co.; Quiver Lake, and Illinois River, Havana, Mason Co.; Thompson's Lake, Fulton Co. (State Laboratory).

Corneocyclas virginica Gmelin.

Cook Co. (Baker); Kankakee River (Ferriss); Joliet, Will Co. (Ferriss, Handwerk); Lilycash Creek, Will Co. (Handwerk); Little Wabash River (Hinkley); Winnebago Co. (Marsh).

Corneocyclas walkeri Sterki.

Joliet, Will Co.; Du Page River (Ferriss); Lilycash Creek, Will Co. (Handwerk).

Class GASTROPODA.

Subclass Anisopleura.

Order PROSOBRANCHIATA.

Superfamily Rhipidoglossa.

Family HELICINIDÆ.

Genus Helicina Lamarck.

Helicina occulta Lamarck.

Athens, Menard Co. (Pilsbry); Moline, Rock Island Co. (Shimek).

Superfamily Tænioglossa.

Family VIVIPARIDÆ.

Genus Vivipara Lamarck.

Vivipara contectoides W. G. Binney.

Cook Co. (Baker, Calkins, Jensen, Nason, Woodruff); Northern Illinois (Calkins); Desplaines River (Ferriss); Romeo, Will Co.; Kankakee and Illinois rivers (Handwerk); Quincy, Adams Co. (Hart); White Co. (Hinkley); La Salle Co. (Huett); Mercer Co.; Henderson Co. (Marsh); Mississippi River, Quincy, Adams Co.; Illinois River (Nason); Thompson's Lake, Fulton Co. (Strode); Fulton Co. (Wolf); Quiver Lake, and Illinois River, Havana, Mason Co.; Peoria, Peoria Co.; Warsaw, Hancock Co.; Pekin Lake, Tazewell Co.; Fulton Co. (State Laboratory).

Vivipara subpurpurea Say.

Northern Illinois (Calkins); Rock Island (Call); Mt. Carmel, Wabash Co. (Daniels); Utica, in canal, La Salle Co. (Ferriss); Quincy, Adams Co. (Garman, Hart); Little Wabash, Saline, and Big Muddy rivers (Hinkley); La Salle Co. (Huett); Pulaski Co. (Lyon); Mercer Co. (Marsh); Mississippi River, Quincy, Adams Co. (Nason); Southern Illinois (Ulffers, as *vivipara*); Fulton Co. (Wolf); Matanzas Lake and Illinois River, Havana, Mason Co.; Peoria, Peoria Co.; Pekin Lake, Tazewell Co.; Thompson's Lake, Fulton Co. (State Laboratory).

Vivipara subpurpurea texana Tryon.

A specimen of this variety is in the collection of the Chicago Academy of Sciences labeled "Illinois" and presented by Mr. W. W. Calkins. The reference seems doubtful.

Vivipara intertexta Say.

Savanna, Carroll Co. (Baker); Northern and Southern Illinois (Calkins); Mt. Carmel, Wabash Co. (Call, Daniels); Putnam Co. (Ferriss); Quincy, Adams Co. (Garman, Hart); Winnebago Co. (Hinkley); Mercer Co. (Marsh); Canton, Fulton Co. (Nason, Wolf); Thompson's Lake, Fulton Co. (Strode); Cypress Swamp, Johnson Co.; Havana, Mason Co.; Flag Lake, Fulton Co. (State Laboratory).

Genus Lioplax Troschel.

Lioplax subcarinata Say.

Northern Illinois; Illinois River (Calkins, Nason); Kankakee River (Ferriss); Mississippi River, Quincy, Adams Co. (Garman, Hart, Nason); all rivers visited (Hinkley); La Salle Co. (Huett); Pulaski Co. (Lyon); Mercer Co. (Marsh); Canton, Fulton Co. (Nason); Quincy, Adams Co.; Pekin Lake, Tazewell Co.; Peoria, Peoria Co.; Matanzas Lake and Illinois River, Mason Co.; Little Fox River, Phillipstown, White Co.; Fulton Co.; Franklin Co. (State Laboratory).

Genus Campeloma Rafinesque.

Campeloma ponderosum Say.

Illinois River (Calkins, Rea); Wabash and Ohio rivers (Hinkley); Ohio River (Marsh); Southern Illinois (Ulffers); Chicago, Cook Co. (Velie).

Conrad says of this shell (New Fresh-water Shells, p. 12): "A common inhabitant of all the rivers of the west, from the northern districts of Illinois and Indiana to the waters of the Tennessee Valley." The Chicago record rests upon a number of specimens said to have been collected in Calumet River by Dr. J. W. Velie. The specimens are true *ponderosum* and are in the collection of the Chicago Academy of Sciences.

Campeloma coarctatum ? Lea.

Cache Creek, Pulaski Co. (Lyon). Specimens of a species of *Campeloma* submitted to Mr. Bryant Walker, were thought by him to be doubtfully this species.

Campeloma decisum Say.

Chicago, Cook Co. (Baker, Higley, Jensen, Woodruff); Northern Illinois (Binney, Calkins); Jerseyville, Jersey Co.; Batavia, Kane Co. (Binney); Du Page River, (Ferriss); Quincy, Adams Co. (Garman); Joliet, Will Co. (Handwerk); all rivers visited (Hinkley); La Salle Co. (Huett); Sangamon Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co. (Nason); Quiver Lake, Havana, Mason Co.; Sand Lake, Lake Co. (State Laboratory).

Campeloma integrum De Kay.

Savanna, Carroll Co.; Oregon, Ogle Co. (Baker); Cook Co. (Baker, Higley, Jensen, Lyon); Kane Co., Fox and Illinois rivers (Calkins); Du Page River (Ferriss); Joliet, Will Co. (Handwerk); Kappa, Woodford Co. (Hart); Hamilton Co. (Lyon); Elgin, Kane Co.; Algonquin, McHenry Co. (Nason); Quincy, Adams Co.; Peoria, Peoria Co.; Fox and Sand lakes, Lake Co.; Havana, Mason Co.; Milan, Rock Island Co.; Fulton Co. (State Laboratory).

Campeloma integrum obesum Lewis.

Fox and Illinois rivers (Calkins); Mercer Co. (John Henry); Cook and Pulaski counties (Lyon); Winnebago Co. (Marsh); Peoria, Peoria Co.; Crooked Creek, Clinton Co.; Quincy, Adams Co. (State Laboratory).

Campeloma rufum Haldeman.

Cook Co. (Baker, Jensen, Lyon, Woodruff); Northern Illinois (Calkins); Du Page River (Ferriss); Joliet, Will Co. (Handwerk); Kappa, Woodford Co. (Hart); Rockford, Winnebago Co. (Hinkley); Mercer and Vermilion counties (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co. (Nason); Fulton Co. (Wolf); Cedar Lake, Lake Co.; Peoria, Peoria Co.; Pekin Lake, Tazewell Co.; Ohio River and Cache Creek, Pulaski Co.; Clear Lake, Cairo, Alexander Co. (State Laboratory).

Campeloma subsolidum Anthony.

Savanna, Carroll Co. (Baker); Cook Co. (Baker, Calkins, Jensen, Lyon); Northern Illinois; Illinois and Fox rivers (Calkins); Grundy Co. (Daniels); Joliet, Will Co. (Handwerk); Quincy, Adams Co. (Hart); La Salle Co. (Huett); Union and Pulaski counties (Lyon); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Athens, Menard Co.; Quincy, Adams

Co. (Nason); Fulton Co. (Wolf); Quincy, Adams Co.; Swanwick Creek, Perry Co.; Fox, Clear, Sand, and Pistakee lakes, Lake Co.; Fulton Co.; Meredosia, Morgan Co.; Crab Orchard Creek, Williamson Co.; Peoria, Peoria Co.; Havana, Mason Co. (State Laboratory).

Campeloma subsolidum exilis Anthony.

Chicago, Cook Co. (Calkins, Higley); Northern Illinois (Calkins); Mercer Co. (Marsh); Quincy, Adams Co. (Nason); Illinois River (Walker); Fulton Co. (Wolf).

Call has recorded *Campeloma milesii* Lea from Mercer Co., but as no authentic *milesii* have as yet been found outside of the state of Michigan this citation must be understood to mean variety *exilis*.

Family VALVATIDÆ.

Genus Valvata Müller.

Valvata sincera Say.

Although no authentic Illinois records of this species have been seen, it is deemed best to include it in this list as it undoubtedly inhabits Northern Illinois.

Valvata lewisii Currier (= *sincera* of authors, not of Say).

Cook Co. (Baker, Calkins, Jensen, Lyon, Nason); Northern Illinois (Calkins); La Salle Co. (Huett); Jo Daviess Co. (Marsh); Lake Michigan, Chicago, Cook Co.; Long Lake, Lake Co. (State Laboratory).

Valvata tricarinata Say.

Cook Co. (Baker, Calkins, Nason); Northern Illinois (Calkins); Desplaines River, Joliet, Will Co. (Ferriss); Quincy, Adams Co. (Garman); Rockford, Winnebago Co. (Hinkley); La Salle Co. (Huett); Lake Co. (Jensen); Crystal Lake, McHenry Co. (Lyon); Mercer Co. (Marsh); Algonquin and Silver Lake, McHenry Co.; Athens, Menard Co. (Nason); Fulton Co. Wolf); Quiver Lake and Quiver Creek, Havana, Mason Co.; Cedar, Fourth, Sand, Fox, Long, and Pistakee lakes, Lake Co.; Thompson's Lake, Fulton Co.; Lake Michigan, Chicago, Cook Co. (State Laboratory).

Valvata tricarinata confusa Walker.

Joliet, Will Co. (Ferriss); Lake Co. (Jensen); Long Lake, Lake Co.; Havana, Mason Co. (State Laboratory).

Valvata bicarinata Lea.

Desplaines River: Lake Michigan, Cook Co. (Baker); Rock River (Ferriss); Joliet, Will Co. (Ferriss, Handwerk); Saline River; Elizabethtown, Hardin Co. (Hinkley); Lake Co. (Jensen); Mercer Co. (Marsh); Long, Sand, and Pistakee lakes, Lake Co.; Slough, Havana, Mason Co. (State Laboratory).

Valvata bicarinata perdepressa Walker.

Lake Michigan, Chicago, Cook Co. (Baker, Jensen, Lyon).

Valvata bicarinata normalis Walker.

Joliet, Will Co. (Ferriss); Willow Springs, Cook Co. (Handwerk); Quincy, Adams Co. (Hart); Lake Co. (Jensen); Crystal Lake, McHenry Co. (Lyon); Cedar, Fox, Long, and Pistakee lakes, Lake Co; Quiver and Matanzas lakes and Havana, Mason Co.; McHenry Co; Fulton Co. (State Laboratory).

Family AMNICOLIDÆ.

Subfamily BYTHINIINÆ.

Genus Bythinia Gray.

Bythinia tentaculata Linné.

Cook Co. (Baker, Jensen, Lyon).

Subfamily HYDROBIINÆ.

Genus Amnicola Gould and Haldeman.

Amnicola limosa Say.

Savanna, Carroll Co. (Baker, Nason); Cook Co. (Baker, Calkins, Jensen, Lyon); Du Page River (Ferriss); Quincy, Adams Co. (Garman); Northern Illinois; Mercer Co. (Marsh); Algonquin, McHenry Co.; Elgin, Kane Co. (Nason); Fulton Co. (Wolf); Cedar, Pistakee, Fox, Long, and Sand lakes, Lake Co.; Lake Michigan, Chicago, Cook Co.; Clear and Quiver lakes, and Illinois River, Mason Co.; Flag and Thompson's lakes, and Spoon River, Fulton Co. (State Laboratory).

Amnicola limosa porata Say (= *orbiculata* Lea).

Cook Co. (Baker, Lyon, Nason); Northern Illinois (Calkins); Kankakee and Du Page rivers (Ferriss); La Salle Co. (Huett); Macoupin and Mercer counties (Marsh); Canton, Fulton Co.; Rock Island, Rock Island Co. (Nason); Fulton Co. (Wolf); Lake Michigan, Chicago, Cook Co.; Fox Lake, Lake Co.; Quiver Lake, Havana, Mason Co. (State Laboratory).

Amnicola limosa parva Lea.

Joliet, Will Co. (Ferriss, Handwerk); Cook Co. (Higley, Jensen); Seifert, Perry Co. (Hinkley); Salt Creek, Cook Co. (Jensen); Northern Illinois; Mercer Co. (Marsh); Fox River, Algonquin, McHenry Co. (Nason); Pistakee, Cedar, Long, and Fox lakes, Lake Co.; Quiver Lake, and Illinois River, Havana, Mason Co.; Thompson's and Flag lakes, Fulton Co.; Drew Pond, two miles from Wabash River, White Co.; Lake Michigan, Chicago, Cook Co.; Urbana, Champaign Co. (State Laboratory).

Amnicola limosa pallida Haldeman.

Kankakee River (Ferriss); Silver Lake, McHenry Co. (Nason); Fox Lake, Lake Co. (State Laboratory).

Amnicola lustrica Pilsbry.

Cook Co. (Baker, Higley); Fox River (Calkins); Joliet, Will Co. (Ferriss); Mason Co. (Hinkley); Crystal Lake, McHenry Co. (Lyon); Silver Lake, Fox River, McHenry Co. (Nason); Fox, Pistakee, Sand, Long, Cedar, and Slough lakes, Lake Co.; Quiver and Matanzas lakes, and Illinois River, Havana, Mason Co.; Lake Michigan, Chicago, Cook Co. (State Laboratory).

Amnicola pilsbryi Walker.

Rockford, Winnebago Co. (Hinkley); Winnebago Co. (Marsh); Sand and Fox lakes, Lake Co. (State Laboratory).

Amnicola walkeri Pilsbry.

Joliet, Will Co. (Ferriss); Fox River, Algonquin, McHenry Co. (Nason); Long Lake, Lake Co. (State Laboratory).

Amnicola decisa Haldeman.

Fulton Co. (Wolf).

Subgenus *Cincinnatia* Pilsbry.

Amnicola cincinnatiensis Lea (= *sayana* Anthony).

Cook Co. (Baker, Calkins, Jensen); Northern Illinois (Calkins); Joliet, Will Co.; Du Page River (Ferriss); Pecatonica River, Winnebago Co.; Little Wabash River; Big and Little Muddy rivers; Ohio River; Du Bois, Washington Co.; Elizabethtown, Hardin Co.; Mason Co. (Hinkley); Peoria Co. (Marsh); Algonquin, McHenry Co. (Nason); Fulton Co. (Wolf); Cedar, Pistakee, and Fourth lakes, Lake Co.; Quiver and Matanzas lakes, and Illinois River, Havana, Mason Co.; Lake Michigan, Chicago, Cook Co.; McHenry Co.; Crystal Lake, Urbana, Cham-

paign Co.; Spoon River and Thompson's Lake, Fulton Co. (State Laboratory).

Amnicola emarginata Küster (= *obtusa* Lea).

Cook Co. (Baker, Calkins, Jensen); Ottawa, La Salle Co.; Northern Illinois; Kankakee River (Calkins); Kankakee River, Utica, La Salle Co. (Ferriss); Mercer Co. (Marsh); Fulton Co. (Wolf); Lake Michigan, Chicago, Cook Co.; Quiver and Matanzas lakes, and Illinois River, Havana, Mason Co. (State Laboratory).

Genus PALUDESTRINA Orbigny.

Paludestrina nickliniana Lea.

Cook Co. (Baker, Higley); Fox River (Calkins); Evanston, Cook Co. (Lyon).

Genus SOMATOGYRUS Gill.

Somatogyrus isogonus Say.

Big Muddy River, Blairsville, Williamson Co. (Hinkley); Quincy, Adams Co. (State Laboratory).

Somatogyrus subglobosus Say.

Cook Co. (Baker, Calkins, Jensen, Lyon, Nason); Northern Illinois (Calkins); Kankakee River; Joliet, Will Co. (Ferriss); Quincy, Adams Co. (Garman); Wabash, Little Wabash, and Ohio rivers; Rockford, Winnebago Co. (Hinkley); Hamilton Co. (Lyon); Mississippi River (Marsh); Canton, Fulton Co.; Athens, Menard Co. (Nason); Spoon River (Strode); Fulton Co. (Wolf); Quincy, Adams Co.; Pekin, Tazewell Co.; Havana, Mason Co.; Peoria, Peoria Co.; Lake Michigan, Chicago, Cook Co. (State Laboratory).

Somatogyrus integer Say.

Rock River (Calkins); Joliet, Will Co. (Ferriss); Wabash River, White Co.; Ohio River, Golconda, Pope Co.; Little Muddy Creek, Rockford, Winnebago Co.; Du Bois, Washington Co.; Elizabethtown, Hardin Co. (Hinkley); Mississippi and Wabash rivers (Marsh).

Somatogyrus integer depressus Tryon.

Du Bois, Washington Co.; Rockford, Winnebago Co.; Peoria, Peoria Co. (Hinkley); Rock Island Co. (Nason).

Somatogyrus currierianus Lea.

Elizabethtown, Hardin Co. (Hinkley).

Subfamily POMATIOPSINÆ.

Genus Pomatiopsis Tryon.

Pomatiopsis cincinnatiensis Anthony.

Northern Illinois (Calkins); Joliet, Will Co.; Kankakee River (Ferriss); Peoria Co. (Marsh); Fulton Co. (Wolf).

Pomatiopsis lapidaria Say (=*lustrica* Say).

Cook Co. (Baker, Higley); Northern Illinois; Ottawa, La Salle Co. (Calkins); Kankakee River; Joliet, Will Co. (Ferriss); Quincy, Adams Co. (Hart); Winnebago Co.; Du Bois, Washington Co. (Hinkley); La Salle Co. (Huett); Winnebago and Mercer counties (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co; Athens, Menard Co. (Nason); Fulton Co. (Wolf); Quiver Lake, Havana, Mason Co.; Bartelso, Clinton Co. (State Laboratory).

Pomatiopsis sheldonii Pilsbry.

Illinois River (Marsh).

Genus Pyrgulopsis Call and Pilsbry.

Pyrgulopsis mississippiensis Pilsbry.

Mississippi River, near mouth of Rock River (Call, Marsh, Pilsbry).

Pyrgulopsis scalariformis Wolf.

Tazewell Co. shore of Illinois River (Wolf).

Family PLEUROCERIDÆ.

Genus Angitrema Haldeman.

Angitrema armigera Say.

Wabash and Ohio rivers (Hinkley); Ohio River (Marsh); Southern Illinois (Ulffers); Ohio River, Golconda, Pope Co. (State Laboratory).

Angitrema verrucosa Rafinesque.

Wabash and Ohio rivers (Hinkley); Ohio River (Marsh); Mt. Carmel, Wabash Co. (Nelson); Ohio River, Golconda, Pope Co. (State Laboratory).

Genus Lithasia Haldeman.

Lithasia undosa Anthony.

Little Wabash and Saline rivers (Hinkley); Ohio River (Marsh).

Lithasia obovata Say.

Ohio River (Marsh).

Genus Pleurocera Rafinesque.

Pleurocera alveare Conrad (=*nupera* Say).

Little Wabash and Saline rivers (Hinkley); Ohio River (Marsh); Southern Illinois (Ulffers).

Pleurocera canaliculatum Say.

Wabash and Ohio rivers (Hinkley); Wabash River (Marsh); Mt. Carmel, Wabash Co. (Nelson); Southern Illinois (Ulffers); Golconda, Pope Co.; Saline River, Saline Co. (State Laboratory).

Pleurocera elevatum Say.

Cook Co. (Baker, Jensen); Joliet, Will Co.; Kankakee River (Ferriss, Handwerk); Kishwaukee and Kaskaskia rivers (Hinkley); Illinois River (Marsh); Spoon River (Strode); Peoria, Peoria Co.; Pekin Lake, Tazewell Co.; Golconda, Pope Co.; Saline River, Saline Co.; Kaskaskia River, Bartelso, Clinton Co.; Pistakee Lake, Lake Co.; Skillet Fork, Wayne Co.; Duncan's Mills and Bernadotte, Fulton Co.; Little Muddy River, Franklin Co.; Havana, Mason Co.; Kishwaukee River, Winnebago Co.; Carlyle, Clinton Co.; Lake Michigan, Chicago, Cook Co. (State Laboratory).

Pleurocera elevatum lewisii Lea.

Northern Illinois; Fox River (Calkins); Utica, La Salle Co.; Joliet, Will Co.; Kankakee River (Ferriss); Quincy, Adams Co. (Hart); La Salle Co. (Huett); Peoria Co. (Lea, Lewis, Marsh, Tryon); Illinois River; Canton, Fulton Co. (Nason); Spoon River (Strode); Fulton Co. (Wolf); Peoria, Peoria Co.; Quiver and Matanzas lakes, and Illinois River, Havana, Mason Co.; Pekin Lake, Tazewell Co.; Thompson's Lake, Fulton Co.; Milan, Rock Island Co. (State Laboratory).

Pleurocera florencense Lea.

Wabash River (Marsh).

Pleurocera lesleyi Lea.

Ohio River (Marsh).

Pleurocera moniliferum Lea.

Wabash, Little Wabash, Saline, and Ohio rivers (Hinkley, Marsh); Ohio River (Lea).

Pleurocera neglectum Anthony.
Big and Little Muddy rivers (Hinkley); Washington Co. (Marsh).

Pleurocera pallidum Lea.
Fox River (Calkins); Kappa, Woodford Co. (Hinkley, collected by C. A. Hart).

Pleurocera ponderosum Anthony.
Illinois River (Ferriss, Marsh); Fox River (Tryon).

Pleurocera subulare Lea.
Cook Co. (Baker, Calkins, Jensen, Lyon); Northern Illinois; Fox River (Calkins); Kankakee River (Ferriss); Rock River and Kent's Creek (Hinkley); La Salle Co. (Huett); Union Co. (Lyon); Mississippi River (Marsh); Fulton Co. (Wolf); Lake Michigan, Chicago, Cook Co.; Havana, Mason Co. (State Laboratory).

Pleurocera subulare intensum Anthony.
Desplaines River (Baker); Cook Co. (Jensen, Velie); Meredosia, Morgan Co. (Woodruff); Quincy, Adams Co. (State Laboratory).

Pleurocera troostii Lea.
Wabash River (Marsh).

Pleurocera undulatum Say.
Wabash and Ohio rivers (Hinkley); Wabash River (Marsh).

Genus GONIOBASIS Lea.

Goniobasis costifera Haldeman.
Creeks of Hardin Co. (Hinkley); Hennepin, Putnam Co. (Haldeman, Tyron); Saline River (Marsh).

Goniobasis plebeius Anthony (= *cubicoides* Anthony).
Kankakee River (Ferriss, Marsh).

Goniobasis depygis Say.
Northern Illinois (Calkins); Kankakee River (Ferriss); Joliet, Will Co. (Ferriss, Handwerk); Hickory Creek, Will Co. (Handwerk); La Salle Co. (Huett); Peoria Co. (Marsh).

Goniobasis gracilior Anthony.
Fulton Co. (Wolf); Peoria, Peoria Co. (State Laboratory).

Goniobasis infantula Lea.
Ohio River (Marsh).

Goniobasis semicarinata Say (= *grosvenorii* Lea).

Hickory Creek, Will Co. (Ferriss); Fox River (Lea); Big Vermilion River (Marsh); Grand Pierre Creek, Herod, Pope Co.; Elizabethtown, Hardin Co.; Bartelso, Clinton Co. (State Laboratory).

Goniobasis livescens Menke.

Cook Co. (Baker, Calkins, Jensen, Lyon); Northern Illinois; Fox River (Calkins); Utica, La Salle Co.; Kankakee River (Ferriss); Kappa, Woodford Co. (Hart); La Salle Co. (Huett); Illinois River (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Illinois River (Nason); Fulton Co. (Wolf); Havana, Mason Co.; Peoria, Peoria Co.; Lake Michigan, Chicago, Cook Co. (State Laboratory).

Goniobasis pulchella Anthony.

Big Vermilion River (Calkins); Desplaines River (Ferriss); Illinois River (Lewis, Marsh).

Goniobasis spartenburgensis Lea.

Mt. Carmel, Wabash Co. (Hinkley, collected by Mr. Charles A. Hodgson).

Genus Anculosa Say.

Anculosa subglobosa Say.

Ohio River (Marsh).

Anculosa prærosa Say.

Wabash and Ohio rivers (Hinkley); Ohio River (Marsh); Southern Illinois (Ulffers); Golconda, Pope Co. (State Laboratory).

Anculosa costata Anthony.

Wabash River (Marsh).

SUBCLASS EUTHYNEURA.

ORDER PULMONATA.

SUBORDER BASOMMATOPHORA.

Superfamily HYGROPHILA.

Family PHYSIDÆ.

Genus PHYSA Draparnaud.

Physa ancillaria Say (= *vinosa* of authors, not of Gould).

Quincy, Adams Co. (Garman); tank pond, Du Bois, Washington Co.; Winnebago Co. (Hinkley); Winnebago Co. (Marsh); Lake Michigan, Cook Co. (Nason).

Physa sayii Tappan.

Cook and Will counties; Northern Illinois (Baker); Fox River; Algonquin, McHenry Co. (Nason); Clear, Sand, and Cedar lakes, Lake Co.; Peoria, Peoria Co.; Urbana, Champaign Co.; Milan, Rock Island Co.; Havana, Mason Co.; Northern Illinois (State Laboratory).

Physa heterostropha Say.

Cook Co. (Baker, Calkins); Southern Illinois (Binney, Ulffers); Quincy, Adams Co. (Garman); Joliet, Will Co.; Kankakee River (Handwerk); Saline River; Winnebago, Washington, and Hardin counties (Hinkley); Mercer Co. (Marsh); Silver and Crystal lakes and Algonquin, McHenry Co. (Nason); Thompson's Lake, Fulton Co. (Strode); Cedar, Pistakee, and Clear lakes, Lake Co.; Quiver Lake, Havana, Mason Co.; Normal, McLean Co.; McHenry Co. (State Laboratory).

Physa anatina Lea.

Elizabethtown, Hardin Co. (Hinkley); Algonquin, McHenry Co. (Nason); Quincy, Adams Co. (State Laboratory).

Physa gyrina Say.

Northern Illinois (Baker, Calkins); Cook Co. (Baker, Calkins, Lyon, Woodruff); Oregon, Ogle Co.; Savanna, Carroll Co. (Baker, Nason); Du Page River (Ferriss); Kankakee River (Handwerk); Winnebago, Jefferson, Hardin, and Washington counties; Saline River (Hinkley); Fulton Co. (Hinkley, Wolf);

La Salle Co. (Huett); Mercer Co. (Marsh); Fox River; Algonquin, Flint Creek and Crystal and Silver lakes, McHenry Co. (Nason); Quincy, Adams Co.; Quiver and Matanzas lakes, and Illinois River, Havana, Mason Co.; Grand Pierre Creek, Herod, Pope Co.; Normal, McLean Co.; Peoria, Peoria Co.; Polecat Creek, Ashmore, Coles Co.; Cypress Creek, Grantsburg, Johnson Co.; Urbana, Champaign Co.; Union Co.; Lake Michigan, Chicago, Cook Co. (State Laboratory).

Physa gyrina oleacea Tryon (= *elliptica* of authors, not of Lea).

Cook Co.; Northern Illinois (Baker, Nason); Quincy, Adams Co. (Hart); Little Muddy River (Hinkley); Algonquin, McHenry Co.; Quincy, Adams Co.; Athens, Menard Co. (Nason); Miller's Pond, Union Co.; Saline Co.; Peoria, Peoria Co.; Pekin, Tazewell Co.; Pistakee and Fourth lakes, Lake Co.; Dixon, Lee Co.; Havana, Mason Co. (State Laboratory).

Physa gyrina hildrethiana Lea.

Cook Co. (Baker, Nason); Northern Illinois (Calkins); La Salle Co. (Huett); a lake in Illinois (Lea); Canton, Fulton Co. (Lewis); Fulton Co. (Marsh, Wolf); Elgin, Kane Co.; Crystal Lake, McHenry Co.; Athens, Menard Co. (Nason).

Physa integra Haldeman (=*niagarensis* Lea).

Savanna, Carroll Co. (Baker); Oregon, Ogle Co.; Cook Co. (Baker, Nason); De Soto, Jackson Co.; Du Bois, Washington Co.; Rockford, Winnebago Co.; Big Muddy River (Hinkley); Elgin, Kane Co.; Crystal and Silver lakes and Algonquin, McHenry Co. (Nason); Blue Mound, Macon Co.; Peoria, Peoria Co.; Pistakee, Fox, Cedar, Sand, and Fourth lakes, Lake Co.; Quiver and Matanzas lakes, and Illinois River, Havana, Mason Co.; Lake Michigan, Chicago, Cook Co.; Bluff Lake, Anna, Union Co.; Pekin Lake, Tazewell Co.; Flag Lake, Fulton Co.; Cedar Creek, Quincy, Adams Co. (State Laboratory).

Physa walkeri Crandall.

Rockford, Winnebago Co. (Hinkley); Elgin, Kane Co. (Nason).

Physa crandalli Baker (=*rhomboidea* Crandall, 1901, not Meek and Hayden, 1856).

Big Muddy and Saline rivers; Jefferson Co. (Hinkley); Athens, Menard Co. (Nason).

Physa sp.

Greenhouse, Douglass Park, Chicago, Cook Co. (Hood, Zetek).

Genus Aplexa Fleming.

Aplexa hypnorum Linné (= *Physa elongata* Say).

Cook Co. (Baker, Higley, Nason); Northern Illinois (Calkins); Desplaines River (Ferriss); Rockford, Winnebago Co. (Hinkley); La Salle Co. (Huett); Canton, Fulton Co (Lewis); Eastern Illinois (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Canton, Fulton Co. (Nason); shores of Illinois (Say); Southern Illinois (Ulffers); Fulton Co. (Wolf).

Family ANCYLIDÆ.

Genus Ancylus Geoffroy.

Section *Lævapex* Walker.

Ancylus diaphanus Haldeman.

Illinois River (Ferriss, Walker).

Ancylus fuscus Adams.

Algonquin and Fox Lake, McHenry Co. (Nason).

Ancylus fuscus euglyptus Pilsbry.

Havana, Mason Co.; Illinois River (Pilsbry).

Ancylus kirklandi Walker.

Havana, Mason Co.; Crystal Lake, Urbana, Champaign Co. (State Laboratory).

Section *Ferrissia* Walker.

Ancylus rivularis Say.

Du Page River (Ferriss); Winnebago and Washington counties (Hinkley); Cook Co. (Jensen); Mercer Co. (Marsh); creek, Algonquin, McHenry Co.; Fox River, Elgin, Kane Co. (Nason); Salt Fork, Urbana, Champaign Co. (State Laboratory).

Ancylus parallelus Haldeman*

Algonquin, McHenry Co. (Nason); Pistakee and Cedar lakes, Lake Co. (State Laboratory).

Ancylus tardus Say.

Northern Illinois; La Salle Co. (Calkins, Huett); Du Page River (Ferriss); Winnebago Co. (Hinkley); Mercer Co. (Marsh); creek, Algonquin, McHenry Co. (Nason); Rockford, Winnebago

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**Ancylus parallelus* Haldeman as quoted by Marsh from Mercer Co., is said by Walker to be *A. tardus*. (Nautilus XVIII., p. 76.)

Co. (Walker); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Ancylus haldemani Bourguignat.

Quiver Lake and Illinois River, Havana, Mason Co. (State Laboratory).

Ancylus pumilus Sterki.

Rockford, Winnebago Co.; Kankakee River (Walker).

Ancylus shimekii Pilsbry.

Salt Fork, Urbana, Champaign Co. (State Laboratory).

Ancylus sp.*

Genus GUNDLACHIA Pfeiffer.

Gundlachia meekiana Stimpson.

Rock Island Co. (Marsh, Pilsbry).

Gundlachia sp.

Quiver Lake, Havana, Mason Co. (State Laboratory).

Family LYMNÆIDÆ.

Subfamily LYMNÆINÆ.

Genus LYMNÆA Lamarck.

Subgenus *Lymnæa* Lamarck.†

Section *Lymnæa* s.s.

Lymnæa stagnalis appressa Say (= *jugularis* Say).

Cook Co. (Baker, Calkins, Jensen, Nason); Northern Illinois (Calkins); Desplaines River (Ferriss, Handwerk); Romeo, Will Co. (Handwerk); La Salle Co. (Huett, for *stagnalis*); Lake Co. (Marsh); Silver Lake and Algonquin, McHenry Co. (Nason); Cedar and Fourth lakes, Lake Co.; Chicago, Cook Co. (State Laboratory).

Section *Radix* Montfort.

Lymnæa auricularia Linné.

Greenhouse, Lincoln Park, Chicago, introduced (Baker, Nason).

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*Ancylus shimekii Pilsbry as quoted by Baker from Joliet and by Pilsbry from Rock Island, is said by Mr. Bryant Walker to be an undescribed species.

†*Lymnæa emarginata* Say is reported from Southern Illinois by Ulffers, but this would seem to be an error, as no authentic specimens of this species from Illinois have been seen by the writer.

Lymnæa columella Say.

Cook Co. (Baker); Little Muddy River, Du Bois, Washington Co.; De Soto, Jackson Co. (Hinkley); McHenry Co. (Marsh).

Lymnæa columella chalybea Gould (= *casta* Lea).

Mercer Co. (Marsh).

Section *Acella* Haldeman.

Lymnæa haldemani Deshayes (= *gracilis* Jay).

Cedar Lake, Lake Co. (State Laboratory).

Subgenus *Galba* Schrank.

Lymnæa obrussa Say (= *desidiosa* of authors, not of Say).

Cook Co. (Baker, Higley); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Joliet, Will Co. (Ferriss, Handwerk); Desplaines River (Ferriss); Mackinaw River, Kappa, Woodford Co. (Hart); Winnebago and Hardin counties (Hinkley); Mercer and Will counties (Marsh); Elgin, Kane Co.; Fox River, Algonquin and Silver Lake, McHenry Co. (Nason); Fulton Co. (Wolf); Dixon, Lee Co.; Panola, Woodford Co.; Galena, Jo Daviess Co.; Cedar, Fox, and Fourth lakes, Lake Co.; Quiver and Matanzas lakes, and Illinois River, Havana, Mason Co.; Urbana and Champaign, Champaign Co.; Thompson's Lake, Fulton Co. (State Laboratory).

Lymnæa obrussa plica Lea (= *exigua* Lea).

Chicago, Cook Co. (Baker, Jensen); Rockford, Winnebago Co. (Hinkley).

Lymnæa obrussa decampi Streng.

Silver Lake and Algonquin, McHenry Co. (Nason); Cedar and Long lakes, Lake Co. (State Laboratory).

Lymnæa obrussa modicella Say.

Cook Co. (Baker, Higley); Elgin, Kane Co; Fox River, Algonquin and Crystal Lake, McHenry Co.; Athens, Menard Co. (Nason); Wabash Co. (Marsh); Urbana, Champaign Co; Illinois River, Havana, Mason Co.; Thompson's Lake, Fulton Co. (State Laboratory).

Lymnæa tazewelliana Wolf.

Tazewell Co. shore of Illinois River, (Wolf). Pleistocene fossil.

Lymnæa sterkii Baker.

Canton, Fulton Co. (Nason).

Lymnæa humilis Say.

Cook Co. (Baker); Desplaines River (Ferriss); Joliet, Will Co. (Ferriss, Handwerk); La Salle Co. (Huett); Mercer Co. (Marsh); Elgin, Kane Co.: Algonquin, McHenry Co.; Canton, Fulton Co. (Nason); Jackson Co. (Walker); Fulton Co. (Wolf); Grand Tower, Jackson Co. (Woodruff); Quiver and Matanzas lakes, Havana, Mason Co. (State Laboratory).

Lymnæa parva Lea (= *curta* Lea).

Joliet, Will Co. (Ferriss, Handwerk); Mercer Co. (Marsh); Athens, Menard Co.; Cook Co.; Algonquin and Crystal Lake, McHenry Co.; Elgin, Kane Co. (Nason); Canton, Fulton Co. (Nason, Walker); Fulton Co. (Wolf); Copperas Creek (Phil. Acad. Sciences); Illinois River, Havana, Mason Co.: Clifton, Iroquois Co. (State Laboratory).

Lymnæa dalli Baker

Rockford, Winnebago Co. (Hinkley); Northern Illinois, in drift (Sterki).

Subgenus *Stagnicola* Leach.

Section *Stagnicola s.s.*

Lymnæa catascopium Say (= *fusiformis* Lea).

Cook Co. (Baker, Jensen, Nason); Northern Illinois (Calkins); Will Co. (Marsh): Lake Michigan, Chicago, Cook Co. (State Laboratory).

Lymnæa catascopium pinguis Say.

Cook Co. (Baker, Calkins).

Lymnæa woodruffi Baker.

Lake Michigan, Cook Co. (Baker, Lyon, Nason, Woodruff, State Laboratory).

Lymnæa caperata Say (= *ferrissi* Baker).

Cook Co. (Baker, Calkins, Jensen, Nason); Northern Illinois (Calkins); Joliet, Will Co. (Ferriss); Winnebago Co. (Hinkley); Lake Co. (Huett); Mercer and Whiteside counties (Marsh); Elgin, Kane Co.; Algonquin and Crystal Lake, McHenry Co. (Nason); Fulton Co. (Wolf); Urbana, Champaign Co.; Cedar Lake, Lake Co.; Clifton, Iroquois Co.; Quincy, Adams Co.; Freeport, Stephenson Co. (State Laboratory).

Lymnæa caperata umbilicata Adams.

Cook Co. (Baker, Jensen, Nason): Joliet, Will Co.; Desplaines River (Ferriss); Kankakee Co. (Marsh).

Lymnæa pallida Adams.

Northern Illinois (Calkins); La Salle Co. (Huett); Winnebago Co. (Marsh).

Lymnæa palustris Müller (= *elodes* Say, *umbrosa* Say, *sufflatus* Calkins).*

Cook Co. (Baker, Calkins, Nason); Northern Illinois (Calkins); Desplaines River (Ferriss); Winnebago Co.; Canton, Fulton Co. (Hinkley, Marsh); Mercer and Lake counties (Marsh); Silver Lake, McHenry Co. (Nason); Southern Illinois (Ulffers, as *fragilis*); Havana, Mason Co. (Walker); Fulton Co. (Wolf); Urbana, Champaign Co.; Flag Lake, Fulton Co.; Quiver Lake, Havana, Mason Co.; Peoria, Peoria Co.; Cedar, Fourth, and Pistakee lakes, Lake Co. (State Laboratory).

Lymnæa palustris michiganensis Walker.

Cook Co. (Baker); Joliet, Will Co. (Ferriss, Handwerk); Winnebago Co. (Hinkley); Havana, Mason Co. (State Laboratory).

Lymnæa reflexa Say (= *zebra* Tryon).

Cook Co. (Baker, Calkins, Lyon, Nason); Northern Illinois (Calkins); Joliet, Will Co.; Desplaines River (Ferriss, Handwerk); Pecatonica, Winnebago Co. (Hinkley); Kappa, Woodford Co. (Hart); La Salle Co. (Huett); Mercer Co. (Marsh); Silver and Crystal lakes and Algonquin, McHenry Co.; Mason Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Quiver Lake, Havana, Mason Co.; Clear and Cedar lakes, Lake Co.; Thompson's Lake, Fulton Co.; Normal, McLean Co.; Running Lake, Union Co.; McHenry Co. (State Laboratory).

Lymnæa reflexa exilis Lea (= *kirtlandiana* Lea, *lanceata* Gould).

Cook Co. (Calkins); Mercer Co.; Desplaines River (Ferriss); Winnebago Co. (Hinkley); Will Co. (Marsh); Algonquin and Silver Lake, McHenry Co. (Nason); Aledo, Mercer Co. (Walker); Cedar Lake, Lake Co.; Northern Illinois (State Laboratory).

**Lymnæa palustris nuttalliana* and *Lymnæa palustris expansa*, recorded in The Mollusca of the Chicago Area, Part II., pp. 276, 277, prove to be forms of *palustris*.

Lymnæa reflexa jolietensis Baker.

Rock Run, Joliet, Will Co. (Ferriss): Elgin, Kane Co.; Crystal Lake, McHenry Co. (Nason).

Lymnæa reflexa walkeri Baker (=*scalaris* Walker, 1892, not Van den Broeck, 1870).

Cook Co. (Baker, Nason); Joliet, Will Co. (Ferriss); Algonquin, McHenry Co. (Nason).

Lymnæa reflexa iowensis Baker.

Joliet, Will Co. (Ferriss).

Lymnæa reflexa crystalensis Baker.

Crystal Lake, McHenry Co. (Lyon): Flint Creek, McHenry Co.: Mason Co. (Nason).

Subfamily **PLANORBINÆ.**

Genus PLANORBIS Müller.

Subgenus *Planorbis s.s.*

Section *Planorbina* Haldeman.

Planorbis glabratus Say.

Northern Illinois (Calkins): Winnebago Co.; Mercer Co.; Pecatonica River (Hinkley): La Salle Co. (Huett); Cypress Creek, Johnson Co.; McHenry Co.: Hamilton Co.; Hawthorne, White Co. (State Laboratory).

Subgenus *Helisoma* Swainson.

Section *Helisoma* Swainson.

Planorbis bicarinatus Say.

Cook Co. (Baker, Calkins, Higley, Jensen, Nason): Northern Illinois (Calkins): La Salle Co. (Calkins, Huett): Desplaines River (Ferriss): Kappa, Woodford Co. (Hart); common throughout the state (Hinkley): Crystal Lake, McHenry Co. (Lyon): Mercer Co. (Marsh): Elgin, Kane Co.; Algonquin, McHenry Co.: Mason Co. (Nason); McHenry Co. (Stearns); Fulton Co. (Wolf); Illinois River and Dogfish, Quiver, and Matanzas lakes and Slough, Havana, Mason Co.; Fourth, Sand, Cedar, Fox. Pistakee, Clear, Long, and Slough lakes, Lake Co.; Pope Co.; Johnson Co.; Thompson's Lake, Fulton Co.; Milan, Rock Island Co.; Panola, Woodford Co.: Pekin, Tazewell Co. (State Laboratory). A white variety from Crystal and Silver lakes, McHenry Co. (Nason).

Section *Pierosoma* Dall.

Planorbis trivolvis Say (= *fallax* Hald., *megastoma* De Kay, *lentus* of authors, not of Say).*

Cook Co. (Baker, Calkins, Lyon, Nason); Southern Illinois (Binney, Ulffers); Northern Illinois (Calkins); Joliet, Will Co.; Desplaines River (Ferriss); Quincy, Adams Co. (Garman); East Branch Du Page River (Gault); Romeo and Joliet, Will Co. (Handwerk); Kappa, Woodford Co.; Quincy, Adams Co. (Hart); Kishwaukee and Little Wabash rivers; Winnebago, Washington, and Hardin counties; Seifert, Perry Co. (Hinkley); La Salle Co. (Huett); Crystal Lake, McHenry Co. (Lyon); Eastern Illinois; Mercer Co. (Marsh); Athens, Menard Co.; Fox River, Algonquin and Silver Lake, McHenry Co.; Elgin, Kane Co. (Nason); Fulton Co. (Wolf); Saline Co.; Champaign Co.; Peoria, Peoria Co.; Quiver Lake, Havana, Mason Co.; Cypress Creek, Johnson Co.; Cedar Lake, Lake Co.; Dug Hill and Miller's Pond, Union Co.; Washington Co.; Thompson's Lake, Fulton Co.; Pekin, Tazewell Co.; Taylorville, Christian Co.; Northern Illinois; Warsaw, Hancock Co. (State Laboratory).

Planorbis trivolvis macrostoma Whiteaves.

Desplaines River, Will Co. (Ferriss); Northern Illinois (Marsh); Fox River and Algonquin, McHenry Co. (Nason).

Planorbis truncatus Miles.

Cook Co. (Baker, Higley, Jensen).

Planorbis sampsoni Ancey.

Athens, Menard Co., collected by E. Hall (Nautilus, IX., p. 36, 1895).

Section *Planorbella* Haldeman.

Planorbis campanulatus Say.

Cook Co. (Baker, Calkins, Higley); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Desplaines River (Ferriss); Romeo and Joliet, Will Co. (Handwerk); Quincy, Adams Co. (Hart); Winnebago Co. (Hinkley, Marsh); Crystal Lake, McHenry Co. (Lyon); Silver and Crystal lakes and Algonquin, McHenry Co. (Nason); McHenry Co. (Stearns); Southern Illinois (Ulffers); Milan, Rock Island Co.; Clear, Cedar, Sand, Fox,

*The references to *Planorbis lentus* Say from Illinois are extremely doubtful, as it is essentially a southern species. It is reported from the following localities: Winnebago Co. (Hinkley); Mercer Co. (Marsh). (See Nautilus, III., p. 23.)

and Fourth lakes, Lake Co.: Pekin Lake, Tazewell Co.; Havana, Mason Co.; Fulton Co.; McHenry Co.; Lake Michigan, Cook Co.; Northern Illinois; Camp Point, Adams Co. (State Laboratory).

Subgenus *Hippeutis* Agassiz.

Section *Menetus* H. & A. Adams.

Planorbis exacuous Say (= *exacutus* of authors).

Joliet, Will Co., Desplaines River (Ferriss); Winnebago Co. (Hinkley); Mercer Co. (Marsh); Chicago, Cook Co.; Algonquin, McHenry Co.; Illinois River (Nason); Fulton Co. (Wolf); Quiver Lake and Havana, Mason Co.; Pistakee, Fourth, Fox, Sand, Long, Cedar, and Slough lakes, and between Cedar and Loon lakes, Lake Co.; Urbana, Champaign Co.; Flag Lake, Fulton Co. (State Laboratory).

Subgenus *Gyraulus* Agassiz.

Planorbis albus Müller (= *hirsutus* Gould).

Rockford, Winnebago Co.; Du Bois, Washington Co. (Hinkley); Algonquin, McHenry Co. (Nason); Pistakee and Cedar lakes, Lake Co.; Northern Illinois (State Laboratory).

Planorbis deflectus Say.

Cook Co. (Baker, Nason); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Desplaines River (Ferriss); Winnebago Co. (Hinkley); Will Co. (Marsh); Silver Lake and Algonquin, McHenry Co. (Nason); Fulton Co. (Wolf); Cedar, Fox, and Pistakee lakes, Lake Co.; Quiver Creek and Quiver and Dogfish lakes, Mason Co.; McHenry Co. (State Laboratory).

Section *Torquis* Dall.

Planorbis parvus Say.

Cook Co. (Baker, Calkins, Lyon, Nason); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Desplaines River (Ferriss); Joliet, Will Co. (Ferriss, Handwerk); Romeo, Will Co. (Handwerk); Rockford, Winnebago Co. (Hinkley); Mercer Co. (Marsh); Algonquin, McHenry Co.; Quincy, Adams Co.; Athens, Menard Co.; Elgin, Kane Co. (Nason); Fulton Co. (Wolf); Thompson's Lake, Fulton Co.; Quiver, Dogfish, and Matanzas lakes and Slough, Havana, Mason Co.; Cedar, Pistakee, Sand, Fox, Fourth, and Slough lakes, Lake Co.; Urbana, Champaign Co. (State Laboratory).

Planorbis dilatatus Gould.
Carbondale, Jackson Co. (Hinkley).

Section *Armiger* Hartmann.

Planorbis crista Linné, 1758 (=*nautileus* Linné, 1767).
Algonquin, McHenry Co. (Nason).

Genus SEGMENTINA Fleming.

Subgenus *Planorbula* Haldeman.

Segmentina armigera Say.
Cook Co. (Baker, Calkins, Nason); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Desplaines River, Joliet, Will Co. (Ferriss); Rockford, Winnebago Co. (Hinkley); Mercer Co. (Marsh); Elgin, Kane Co.; Silver and Crystal lakes and Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Fulton Co. (Wolf); Glen Ellyn, Du Page Co. (Woodruff); Quiver Lake, Havana, Mason Co.; Urbana, Champaign Co.; Fourth Lake, Lake Co.; McHenry Co. (State Laboratory).

Superfamily AKTEOPHILA.

Family AURICULIDÆ.

Genus CARYCHIUM Müller.

Carychium exiguum Say.
Cook Co. (Baker, Jensen); Northern Illinois; Fox River (Calkins); La Salle Co. (Calkins, Huett); Joliet, Will Co. (Ferriss); Lilycash Creek, Will Co. (Handwerk); Rockford, Winnebago Co.; Du Bois, Washington Co. (Hinkley); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Fulton Co. (Wolf).

Carychium exile H. C. Lea.
Oregon, Ogle Co. (Baker); Cook Co. (Baker, Higley, Jensen); Joliet, Will Co. (Ferriss); Algonquin, McHenry Co. (Nason).

Suborder STYLOMMATOPHORA.

MONOTREMATA.

Vasopulmonata.

ORTHURETHRA.

Family VALLONIIDÆ.

Genus Vallonia Risso.

Vallonia pulchella Müller (= *Helix minuta* Say).

Cook Co. (Baker, Higley, Jensen); Joliet, Will Co. (Ferriss, Handwerk); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co. (Nason); Fulton Co. (Wolf).

Vallonia costata Müller.

La Salle Co. (Calkins); Rock Island Co. (Marsh); Algonquin, McHenry Co. (Nason).

Vallonia parvula Sterki.

Joliet, Will Co. (Ferriss, Handwerk); Algonquin, McHenry Co. (Nason); Will Co. (Sterki).

Family PUPIDÆ.

Genus Strobilops Pilsbry.

Strobilops labyrinthica Say.

Cook Co. (Baker, Jensen); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Utica and Sheridan, La Salle Co. (Ferriss); Winnebago and Washington counties (Hinkley); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf).

Strobilops affinis Pilsbry.

Oregon, Ogle Co.; Evanston, Cook Co. (Baker); Algonquin, McHenry Co. (Nason).

Strobilops virgo Pilsbry.

Elgin, Kane Co.; Algonquin, McHenry Co. (Nason).

Genus Pupoides Pfeiffer.

Pupoides marginata Say (= *fallax* Say of American authors, not of Say).

Oregon, Ogle Co. (Baker); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Joliet, Will Co. (Ferriss, Hand-

werk); Lilycash Creek, Will Co. (Handwerk); Cook Co. (Higley, Nason); Winnebago Co. (Hinkley); Mercer Co. (Marsh); Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Aurora, Kane Co. (Oakes); Fulton Co. (Wolf).

Genus Bifidaria Sterki.

Section *Bifidaria s.s.*

Bifidaria corticaria Say.

Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Sheridan, La Salle Co. (Ferriss); Mt. Carmel, Wabash Co. (Gratacap); Washington Co. (Hinkley); Will Co. (Marsh); Fulton Co. (Wolf).

Bifidaria procera Gould (= *rupicola* of authors not of Say).

Joliet, Will Co.; Du Page Co. (Ferriss); Will Co. (Marsh); Fulton Co. (Wolf).

Section *Albinula* Sterki.

Bifidaria armifera Say.

Oregon, Ogle Co. (Baker); Cook Co. (Baker, Higley, Jensen); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Peoria Co. (Chamberlain); Stark Co. (Chase); Joliet, Will Co.; Utica, La Salle Co. (Ferriss, Handwerk); Winnebago and Washington counties (Hinkley); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Fulton Co. (Wolf); Illinois River, Havana, Mason Co. (State Laboratory).

Bifidaria contracta Say.

Oregon, Ogle Co. (Baker); Cook Co. (Baker, Jensen); La Salle Co. (Calkins); Stark Co. (Chase); Joliet, Will Co. (Ferriss, Handwerk); Mt. Carmel, Wabash Co. (Gratacap); Washington Co. (Hinkley); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Bifidaria holzingeri Sterki.

Joliet, Will Co. (Ferriss, Handwerk); Northern Illinois; Will and La Salle counties (Ferriss, Sterki); Will Co. (Marsh).

Section *Vertigopsis* (Cockerell) Sterki.

Bifidaria tappaniana C. B. Adams (=*pentodon* of authors, not of Say).

Cook Co. (Baker, Jensen); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Stark Co. (Chase); Joliet, Will Co. (Ferriss); Washington and Winnebago counties (Hinkley); Will and Fulton counties (Marsh); Canton, Fulton Co. (Nason).

Bifidaria pentodon Say (=*curvidens* Gould).

Cook Co. (Baker, Jensen); Ottawa, La Salle Co. (Calkins); Joliet, Will Co. (Ferriss, Handwerk); Eastern Illinois (Marsh).

Bifidaria pentodon floridana Dall.

Huntley, McHenry Co. (Ferriss).

Genus PUPILLA Leach.

Pupilla muscorum Linné.

Mercer Co. (Marsh).

Genus VERTIGO Draparnaud.

Subgenus *Angustula* Sterki.

Vertigo milium Gould.

Washington and Winnebago counties (Hinkley, Marsh); Elgin, Kane Co.; Algonquin, McHenry Co. (Nason); Canton, Fulton Co. (Nason, Wolf).

Subgenus *Vertigo* Draparnaud.

Section *Vertigo* s.s.

Vertigo ovata Say (= *Zonites upsoni* Calkins).

Rockford, Winnebago Co. (Calkins, Hinkley); Joliet, Will Co. (Ferriss, Handwerk); Winnebago Co. (Marsh); Algonquin, McHenry Co.; Canton, Fulton Co. (Nason); Fulton Co. (Wolf).

Vertigo ventricosa Morse.

Illinois (Pilsbry).

Vertigo ventricosa approximata Sterki.

Winnebago Co. (Marsh).

Vertigo gouldi Binney.

Rockford. Winnebago Co. (Hinkley); Will Co. (Marsh).

Vertigo tridentata Wolf.

Joliet, Will Co.; Utica, La Salle Co. (Ferriss, Handwerk); Canton, Fulton Co. (Gratacap, Hinkley, Marsh, Nason, Wolf); Fulton Co. (Marsh).

Family COCHLICOPIDÆ.

Genus Cochlicopa (Ferussac) Risso.

Cochlicopa lubrica Müller.

Cook Co. (Baker, Higley); Wilmington, Will Co. (Ferriss); McHenry Co. (Marsh); Algonquin, McHenry Co. (Nason).

HETERURETHRA.

Superfamily Elasmognatha.

Family SUCCINEIDÆ.

Genus Succinea Draparnaud.

Succinea ovalis Say (=*obliqua* Say).

Oregon, Ogle Co.; Cook Co.; Savanna, Carroll Co. (Baker); Northern Illinois (Calkins); Fox River (Calkins, Ferriss); La Salle Co. (Calkins, Huett); Joliet, Will Co.; Bristol, Kendall Co. (Ferriss, Handwerk); Quincy, Adams Co. (Hart); Will Co. (Marsh); Carpentersville, Kane Co.; Algonquin, McHenry Co. (Nason); Fulton Co. (Wolf); Matanzas Lake, Havana, Mason Co. (State Laboratory).

Succinea ovalis totteniana Lea.

Cook Co. (Baker, Jensen, Nason); Joliet, Will Co. (Ferriss); Algonquin, McHenry Co. (Nason).

Succinea retusa Lea (=*ovalis* Gould, *calumetensis* Calkins).

Cook Co. (Baker, Calkins, Jensen, Lyon); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Kankakee River (Ferriss); Joliet, Will Co. (Ferriss, Handwerk); Washington and Winnebago counties (Hinkley); Crystal Lake, McHenry Co. (Lyon); Mercer Co. (Marsh); Algonquin, McHenry Co. (Nason); Glen Ellyn, Du Page Co. (Woodruff); Quiver and Matanzas lakes, and Illinois River, Havana, Mason Co.; Cedar Lake, Lake Co.; Flag and Thompson's lakes, Fulton Co.; Peoria, Peoria Co.; Normal, McLean Co. (State Laboratory).

Succinea retusa magister Pilsbry.

Cook Co. (Baker); Rock Island (Pilsbry).

Succinea retusa peoriensis Wolf.

Kankakee River (Ferriss); Peoria Co. (Wolf).

Succinea avara Say (=*vermeta* Say, *wardiana* Lea).

Oregon, Ogle Co. (Baker); Cook Co. (Baker, Higley); North-

ern Illinois, Illinois River (Calkins); La Salle Co. (Calkins, Huett); Joliet, Will Co. (Ferriss, Handwerk); Washington and Hardin counties (Hinkley); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co. (Nason); Starved Rock, La Salle Co. (Oakes); Fulton Co. (Wolf); Herod, Pope Co. (State Laboratory).

Succinea nuttalliana Lea.

Rockford, Winnebago Co. (Hinkley); Fulton Co. (Wolf).

Succinea higginsi Bland.

Rock Island Co. (Marsh).

Succinea concordialis Gould.

Du Bois, Washington Co. (Hinkley).

Succinea grosvenorii Lea (=*mooresiana* Lea).

Canton, Fulton Co. (Nason, Wolf).

Succinea aurea Lea.

Effingham Co. (Marsh).

Succinea illinoisensis Wolf.

Canton, Fulton Co. (Handwerk); Fulton Co. (Marsh).

SIGMURETHRA.

Superfamily HOLOPODA.

Family HELICIDÆ.

Subfamily POLYGYRINÆ.

Genus POLYGYRA (Say) Pilsbry.

Section *Polygyra s.s.*

Polygyra leporina Gould.

Jackson and Hardin counties (Hinkley); Jackson Co. (Marsh).

Section *Triodopsis* Rafinesque.

Polygyra tridentata Say.

Near Berry Lake, Chicago, Cook Co. (Higley); Hancock Co. (Marsh); Southern Illinois (Ulffers); Golconda, Pope Co. (State Laboratory).

Polygyra tridentata juxtigens Pilsbry.

La Salle Co. (Calkins); Cook Co. (Higley).

Polygyra fraudulenta Pilsbry (= *fallax* of authors, not of Say).

La Salle Co. (Calkins); Lemont, Cook Co. (Higley); Pope and Hardin counties (Hinkley); Union Co. (Lyon); Grand

Tower, Jackson Co. (Woodruff); Cypress Swamp, Johnson Co. (State Laboratory).

Polygyra fallax Say (= *introferens* Binney).

La Salle Co. (Calkins); Knox Co. (Lyon).

Two undoubted specimens of this species are in the collection of the Chicago Academy of Sciences, received from Mr. W. W. Calkins. As the locality is somewhat north of its known range the record from La Salle Co. must be looked upon with suspicion until verified.

Polygyra inflecta Say.

Northern Illinois (Calkins); Cook Co. (Higley); Jackson Co. (Hinkley, Woodruff); Wabash Co. (Marsh); Cypress Swamp, Johnson Co.; Grand Tower, Jackson Co. (State Laboratory).

Polygyra profunda Say.

Oregon, Ogle Co. (Baker); Cook Co. (Baker, Higley, Jensen); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Joliet, Will Co. (Ferriss, Handwerk, Nason); Winnebago Co. (Hinkley); Mercer Co. (Marsh); Rock Island (Nason); Spoon River, Fulton Co. (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf).

Polygyra profunda alba Witter.

Cook Co. (Baker); Joliet, Will Co. (Ferriss).

Polygyra sayii Binney (= *diodonta* Say).

Northern Illinois (Calkins); Edgar Co. (Marsh).

Polygyra albolabris Say.

Cook Co. (Baker, Higley, Jensen); Fox River; Northern Illinois (Calkins); La Salle Co. (Calkins, Ferriss, Huett); Joliet, Will Co. (Ferriss, Handwerk); Marion Co. (Hinkley); Mercer Co. (Marsh); Algonquin, McHenry Co.; Elgin, Kane Co.; Athens, Menard Co. (Nason); Spoon River, Fulton Co. (Strode); Southern Illinois (Ulffers); Grand Tower, Jackson Co. (Woodruff); Normal, McLean Co.; Cairo, Alexander Co. (State Laboratory).

Polygyra albolabris traversensis Leach.

Summit, Cook Co. (Zetek).

Polygyra albolabris dentata Tryon.

Cook Co. (Baker).

Polygyra exoleta Binney.

Northern Illinois (Calkins); La Salle Co. (Calkins, Huett, Marsh); Cook Co. (Higley); Grand Tower, Jackson Co. (Woodruff).

Polygyra multilineata Say (= vars. *alba* and *rubra* Witter).

Oregon, Ogle Co.; Savanna, Carroll Co. (Baker); Northern Illinois (Calkins); Cook Co. (Calkins, Higley, Jensen); La Salle Co. (Calkins, Huett); Peoria Co. (Chase); Kendall Co. (Ferriss); Joliet, Will Co.; Utica, La Salle Co. (Ferriss, Handwerk); Winnebago Co. (Hinkley); Elgin, Kane Co. (Jensen, Nason); Knox Co. (Lyon); Mercer Co. (Marsh); Fulton Co. (Wolf); Havana, Mason Co.; Bernadotte, Fulton Co. (State Laboratory).

Polygyra multilineata algonquinensis (Nason).

Algonquin, McHenry Co. (Nason).

Polygyra palliata Say.

Wabash Co. (Hinkley); Hamilton, Hancock Co.; Union Co. (Lyon); White Co. (Marsh); Southern Illinois (Ulffers); Normal, McLean Co.; Cypress Swamp, Johnson Co.; Dug Hill, Union Co.; Golconda, Pope Co. (State Laboratory).

Polygyra appressa Say.

Alton, Madison Co. (Ferriss); Washington and Jackson counties (Hinkley); Albion, Edwards Co. (Hodgson); Henderson Co. (Marsh); Bernadotte, Fulton Co. (State Laboratory).

Polygyra obstricta Say.

White Co. (Marsh).

Polygyra elevata Say.

Vermilion Co. (Marsh); Spoon River, Fulton Co. (Strode); Southern Illinois (Ulffers).

Polygyra pennsylvanica Green.

Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Joliet, Will Co. (Ferriss, Handwerk); La Salle Co. (Ferriss, Marsh); Washington and Jackson counties (Hinkley); Hamilton, Hancock Co. (Lyon); Fulton Co. (Wolf).

Polygyra thyroides Say.

Cook Co. (Baker, Higley, Jensen); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Joliet, Will Co. (Ferriss, Handwerk); Washington, White, and Hardin counties (Hink-

ley); Union Co.; Hamilton, Hancock Co. (Lyon); Mercer Co. (Marsh); Athens, Menard Co. (Nason); Southern Illinois (Ulffers); Fulton Co. (Wolf); Grand Tower, Jackson Co. (Woodruff); Havana, Mason Co.; Urbana, Champaign Co.; Peoria, Peoria Co. (State Laboratory).

Polygyra clausa Say.

Oregon, Ogle Co. (Baker); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Joliet, Will Co. (Ferriss, Handwerk); Kappa, Woodford Co. (Hart); Winnebago and Washington counties (Hinkley); Cook Co.; Willow Springs, Cook Co. (Jensen); Mercer Co. (Marsh); Chicago, Cook Co.; Canton, Fulton Co. (Nason) Fulton Co. (Wolf); Cairo, Alexander Co. (State Laboratory).

Polygyra mitchelliana Lea.

Starved Rock, La Salle Co. (Baker); La Salle Co. (Calkins); Mercer Co. (Marsh); Spoon River, Fulton Co. (Strode).

Section *Stenotrema* Rafinesque.

Polygyra stenotrema Ferussac.

McHenry Co. (Pilsbry).

Polygyra hirsuta Say.

Oregon, Ogle Co. (Baker); Cook Co. (Baker, Higley); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Joliet, Will Co. (Ferriss, Handwerk); Kappa, Woodford Co. (Hart); Winnebago, Jackson, and Washington counties (Hinkley); Henderson Co. (Marsh); Canton, Fulton Co. (Nason); Southern Illinois (Ulffers); Grand Tower, Jackson Co. (Woodruff); Urbana, Champaign Co. (State Laboratory).

Polygyra monodon Rackett (= *leai* Ward).

Cook Co. (Baker, Higley); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett, Marsh); Stark Co. (Chase); Joliet, Will Co., Utica, La Salle Co. (Ferriss, Handwerk); Cass Co. (Gratacap); Willow Springs, Cook Co. (Jensen); Mercer Co. (Marsh); Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Fulton Co. (Wolf); Havana, Mason Co.; Normal, McLean Co. (State Laboratory).

Polygyra monodon fraterna Say.

La Salle Co. (Calkins); Joliet, Will Co. (Ferriss); Evanston, Cook Co. (Higginson); Vermilion Co. (Marsh); Algonquin,

McHenry Co.; Chicago, Cook Co.; Canton, Fulton Co. (Nason); Southern Illionis (Ulffers); Fulton Co. (Wolf); Grand Tower, Jackson Co. (Woodruff); Makanda, Jackson Co. (State Laboratory).

Family ACHATINIDÆ.

Genus OPEAS Albers.

Opeas mauritianum Pfeiffer.

Garfield Park greenhouse, Chicago, Cook Co. (Hood, Zetek).

Superfamily AGNATHA.

Family TESTACELLIDÆ.

Genus TESTACELLA Cuvier.

Testacella haliotidea Ferussac.

Chicago, in greenhouses, Lincoln Park (Baker).

Superfamily AGNATHOMORPHA.

Family CIRCINARIIDÆ.

Genus CIRCINARIA (Beck) Pilsbry.

Circinaria concava Say.

Oregon, Ogle Co.; Evanston, Cook Co. (Baker); Cook Co. (Baker, Jensen, Nason); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Kankakee River, Joliet, Will Co.; Utica, La Salle Co. (Ferriss); Kappa, Woodford Co. (Hart); Winnebago, White, and Jackson counties (Hinkley); Hamilton Co. (Lyon); Mercer Co. (Marsh); Athens, Menard Co.; Canton, Fulton Co. (Nason); Fulton Co (Wolf); Grand Tower, Jackson Co. (Woodruff); Urbana, Champaign Co. (State Laboratory).

Superfamily AULACOPODA.

Family ZONITIDÆ.

Subfamily ZONITINÆ.

Genus OMPHALINA Rafinesque.

Omphalina fuliginosa Griffith.

Maywood, Cook Co. (Higley); Williamson Co. (Hinkley); Cobden, Union Co. (Lyon); Gallatin Co. (Marsh); Grand Tower, Jackson Co. (Woodruff).

Omphalina inornata Say.
La Salle Co. (Calkins).

Omphalina laevigata Pfeiffer.
Illinois (Binney, Bland); Edgar Co. (Marsh).

Omphalina friabilis W. G. Binney.
Southern Illinois (Binney, Pilsbry); Shelby Co. (Marsh).

Genus Vitrina Draparnaud.

Vitrina limpida Gould.
La Salle Co. (Marsh).

Genus Vitrea Fitzinger.

Vitrea draparnaldi Beck.*
Chicago, greenhouses in Lincoln Park (Baker).

Vitrea hammonis Ström (= *radiatula* Alder, *electrina* Gould, *viridula* Menke).
Cook Co. (Baker, Nason); Joliet, Will Co. (Ferriss); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Vitrea wheatleyi Bland.
Washington Co. (Hinkley); Fulton Co. (Marsh).

Vitrea cellaria Müller.
Chicago, Cook Co., in greenhouses, Lincoln Park (Baker, Calkins); Rockford, Winnebago Co., in greenhouses (Hinkley); La Salle Co. (Marsh).

Section *Glyphyalina* Martens.

Vitrea indentata Say.
Cook Co. (Baker, Jensen, Nason); Joliet, Will Co. (Ferriss); Southern Illinois (Hinkley); Henderson Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Fulton Co. (Wolf).

Genus Euconulus Reinhardt.

Euconulus fulvus Draparnaud.
Cook Co. (Baker, Jensen, Nason); Northern Illinois (Calk-

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* *Vitrea alliarius* Müller has been reported from the greenhouses of Chicago by Calkins and Gratacap, but the record has not been substantiated by later collectors. The specimens so identified might have been either *cellaria* or *draparnaldi*, which are common in the greenhouses of Chicago.

ins); Joliet, Will Co.; Utica, La Salle Co. (Ferriss); Winnebago and Washington counties (Hinkley); Mercer Co. (Marsh); Algonquin, McHenry Co.; Athens, Menard Co. (Nason).

Euconulus fulvus mortoni Jeffries.

Huntley, McHenry Co. (Ferriss).

Euconulus chersinus Say.

Cook Co. (Baker); Algonquin, McHenry Co. (Nason); Fulton Co. (Wolf).

Subfamily ARIOPHANTINÆ.

Genus ZONITOIDES Lehmann.

Zonitoides nitidus Müller.

Oregon, Ogle Co. (Baker); Cook Co. (Baker, Higley, Jensen); Northern Illinois (Calkins); Joliet, Will Co. (Ferriss); Union Co. (Lyon); Will Co. (Marsh); Algonquin, McHenry Co. (Nason); Grand Tower, Jackson Co. (Woodruff); McHenry Co. (State Laboratory).

Zonitoides arboreus Say.

Oregon, Ogle Co. (Baker); Cook Co. (Baker, Higley, Jensen, Lyon); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Peoria Co. (Chamberlain); Joliet, Will Co. (Ferriss); Lemont, Cook Co. (Higley); common throughout the state (Hinkley); Union Co. (Lyon); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Fulton Co. (Wolf); Havana, Mason Co. (State Laboratory).

Section *Pseudohyalina* Morse.

Zonitoides limatulus Ward.

Washington Co. (Hinkley); Hamilton Co. (Marsh).

Zonitoides minusculus Binney.

Cook Co. (Baker, Jensen, Nason); Northern Illinois (Calkins); Joliet, Will Co.; Utica, La Salle Co. (Ferriss); Du Bois, Washington Co. (Hinkley); Mercer Co. (Marsh); Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Canton, Fulton Co. (Nason, Wolf); Havana, Mason Co. (State Laboratory).

Zonitoides milium Morse.

McHenry Co. (Marsh).

Genus GASTRODONTA Albers.

Gastrodonta ligera Say.

Joliet, Will Co.; Utica, La Salle Co. (Ferriss); Cook Co. (Higley); Williamson Co. (Hinkley); Vermilion Co. (Marsh).

Gastrodonta intertexta Binney.

White Co. (Hinkley); Vermilion Co. (Marsh).

Gastrodonta demissa Binney.

Northern Illinois (Calkins); Cook Co. (Higley); Du Bois, Washington Co. (Hinkley).

Gastrodonta gularis Say.

Northern Illinois (Calkins).

Gastrodonta interna Say.

Macoupin Co. (Marsh).

Family LIMACIDÆ.

Genus LIMAX Linné.

Limax maximus Linné.

Chicago, greenhouses in Lincoln Park (Baker).

Limax flavus Linné.

Chicago, greenhouses in Lincoln Park (Baker).

Genus AGRIOLIMAX Mörch.

Agriolimax campestris Binney.

Cook Co. (Baker, Lyon); Mercer Co. (Marsh); Urbana, Champaign Co.; Normal, McLean Co.; Havana, Mason Co. (State Laboratory).

Agriolimax agrestis Linné.

Mercer Co. (Marsh).

Family PHILOMYCIDÆ.

Genus PHILOMYCUS (Rafinesque) Ferussac.

Philomycus carolinensis Bosc.

Cook Co. (Baker); Union Co. (Lyon); Mercer Co. (Marsh); Bernadotte, Spoon River, Fulton Co.; White Heath, Champaign Co.; Golconda, Pope Co.; Anna, Union Co.; Savanna, Carroll Co. (State Laboratory).

Family ENDODONTIDÆ.

Subfamily ENDODONTINÆ.

Genus Pyramidula Fitzinger.

Subgenus *Patula* Held.

Pyramidula alternata Say (= var. *mordax* of authors, not of Shuttleworth).

Oregon, Ogle Co. (Baker); Cook Co. (Baker, Higley, Lyon); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Joliet, Will Co. (Ferriss, Handwerk); Winnebago and Williamson counties (Hinkley); Albion, Edwards Co. (Hodgson); Union Co. (Lyon); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Spoon River, Fulton Co. (Strode); Southern Illinois (Ulffers); Fulton Co. (Wolf); Du Page Co.; Grand Tower, Jackson Co. (Woodruff); Normal, McLean Co.; Peoria, Peoria Co.; Bernadotte, Fulton Co.; Bloomington, McLean Co.; Panola, Woodford Co.; Towanda, McLean Co. (State Laboratory).

Pyramidula solitaria Say.

Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Joliet, Will Co. (Ferriss, Handwerk); Cook Co. (Higley); Du Bois, Washington Co. (Hinkley); Will Co. (Marsh); Macon Co. (Nason); Fulton Co. (Wolf).

Subgenus *Gonyodiscus* Fitzinger.

Pyramidula striatella Anthony.

Cook Co. (Baker, Higley, Jensen); Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); Peoria Co. (Chamberlain); Stark Co. (Chase); Joliet, Will Co. (Ferriss, Handwerk); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co. (Nason); Fulton Co. (Wolf).

Pyramidula perspectiva Say.

Northern Illinois; La Salle Co. (Calkins); Southern Illinois (Hinkley); Union Co. (Lyon); Mercer Co. (Marsh); Brown Co. (Nason); Canton, Fulton Co. (Nason, Wolf); Southern Illinois (Ulffers); Grand Tower, Jackson Co. (Woodruff); Cairo, Alexander Co. (State Laboratory).

Genus Helicodiscus Morse.

Helicodiscus lineatus Say.

Oregon, Ogle Co. (Baker); Cook Co. (Baker, Higley, Jensen, Lyon, Nason, Woodruff); Cook Co.; Northern Illinois (Calkins); La Salle Co. (Calkins, Huett); La Salle Co.; Joliet, Will Co. (Ferriss); Winnebago and Washington counties (Hinkley); Mercer Co. (Marsh); Elgin, Kane Co.; Algonquin, McHenry Co.; Athens, Menard Co. (Nason); Fulton Co. (Wolf)*; Havana, Mason Co. (State Laboratory).

Subfamily PUNCTINÆ.

Genus Punctum Morse.

Punctum pygmæum Draparnaud.

Joliet, Will Co.; Huntley, McHenry Co. (Ferriss); Joliet, Will Co. (Handwerk); Du Bois, Washington Co. (Hinkley); Cook Co. (Jensen); Will Co. (Marsh).

Genus Sphyradium Charpentier.

Sphyradium edentulum Draparnaud (= *Vertigo simplex* Gould).

Eastern Illinois (Marsh); Canton, Fulton Co. (Nason, Wolf).

**Stenotrema lineata* Say is recorded by Wolf from Fulton County. *Helicodiscus lineatus* is probably what was meant. (See Am. Journ. Conch., VI., p. 27.)

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ERRATA AND ADDENDUM.

Page 55, line 15, for *1854* read *1855*.

Page 55, line 16, for *Horticultural*, read *State Agricultural*.

Page 60, in second table, Illinois, for *240* read *241*.

Page 65, last line above foot-note, for *ventricosa* read *ligamentina*.

Page 72, line 9, for *imbecilis* read *imbecillis*.

Page 79, line 19, for *asperimus* read *asperrimus*.

Page 80, insert Section *Fusconaia* Simpson, above *Quadrula rubiginosa*.

BULLETIN

OF THE

ILLINOIS STATE LABORATORY

OF

NATURAL HISTORY

URBANA, ILLINOIS, U. S. A.

VOL. VII. JANUARY, 1907 ARTICLE VII.

ON THE BIOLOGY OF THE SAND AREAS OF ILLINOIS.

BY

CHARLES A. HART AND HENRY ALLAN GLEASON, Ph.D.

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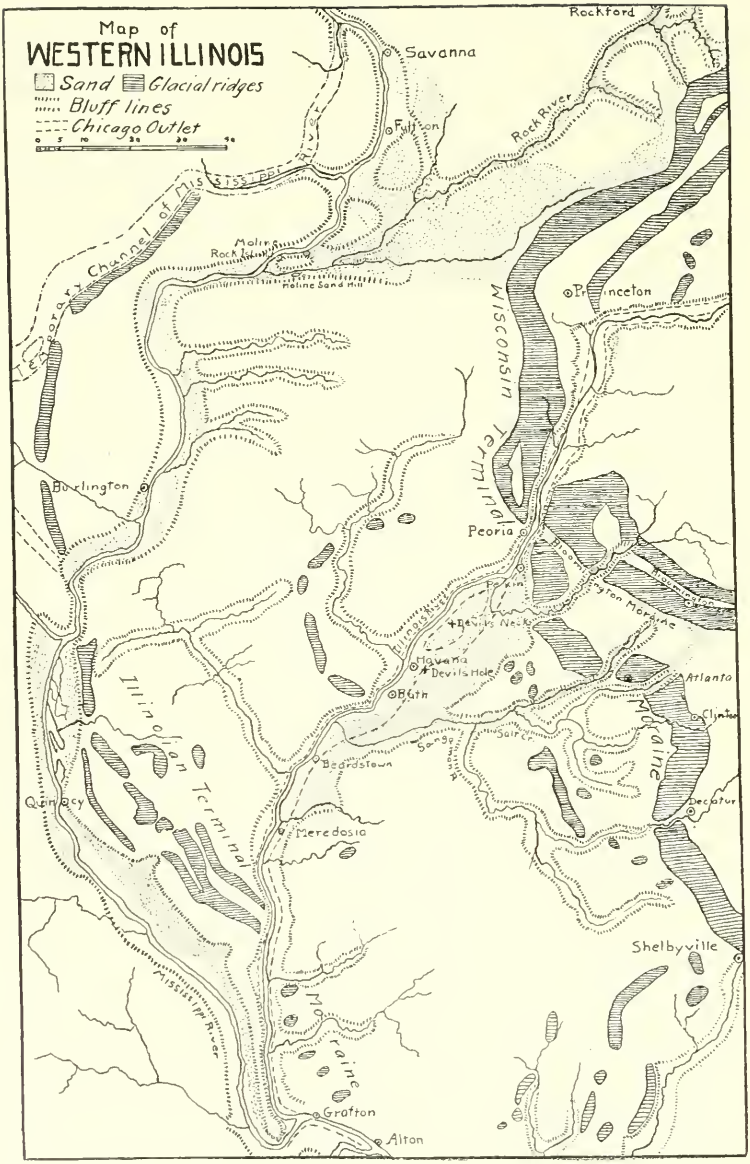
Map of
WESTERN ILLINOIS
Sand
Glacial ridges
Bluff lines
Chicago Outlet
0 5 10 20 30 40
Rockford
Savanna
Fulton
Rock River
Mississippi River
Temporary Channel of Mississippi
Moline
Rock Isl.
Moline Sand Hill
Princeton
Wisconsin Terminal
Burlington
Peoria
Pekin
Bloomington Moraine
Bloomington
Illinois R.
Devils Neck
Havana
Devils Hole
Bath
Atlanta
Clinton
Moraine
Salt Cr.
Sangamon R.
Beardstown
Illinoian Terminal
Quincy
Decatur
Meredosia
Shelbyville
Mississippi River
Moraine
Grafton
Alton

Article VII.—*On the Biology of the Sand Areas of Illinois.* By Charles A. Hart and Henry Allan Gleason.

Introduction.

While located at Havana in connection with the work of the Illinois Biological Station on the Illinois River, the writer made a few trips to the tract of waste sandy land lying east of the city, locally known as the Devil's Hole. A novel fauna and flora were noted, but no systematic study of either was attempted until August, 1903, when a brief survey was made of this locality and of similar regions southeast and south of Havana in company with Mr. H. A. Gleason, of the Department of Botany at the University of Illinois, who studied the flora, the writer giving attention to the fauna, especially to the insect life. At the same season in the following year we made a second visit to these regions, and also examined the sandy tract lying northeast of Havana, between that city and Pekin, which culminates in a remarkable barren area called the Devil's Neck. The botanical results of these two trips are presented by Mr. Gleason as the second part of this joint article. In 1905 I was enabled to make brief comparative examinations of these same regions in the early part of the season, and of similar sand areas in other parts of western Illinois in August and September. In 1906 I paid a brief visit June 23 to the Illinois valley sand region, stopping off at Bishop, Ill.; and in August spent a few days studying the sandy reaches on the flats bordering Lake Michigan above Waukegan, Ill. Delays in going to press have enabled me to include herein some important data from the latter locality concerning species already on the list. The limited amount of time available for these visits enabled me merely to secure some knowledge of the abundant, varied, and largely unfamiliar insect fauna, and to develop a large crop of highly interesting biological problems for future investigation.

Part III. consists largely of some discussion of these problems, followed by an annotated list of species which it is hoped may be an acceptable contribution to the knowledge of the insect life of Illinois. A comparison of these western Illinois areas with those of the northeastern part of the state is greatly to be desired, as the indications are that their biotas differ considerably, and are derived more or less from different geographical sources.

In addition to the faunal studies, I have given particular attention to the topography and remarkable glacial history—especially with regard to the origin of the sand areas and their fauna—of the Illinois River valley, nearly the entire length of which I have traversed at one time or another. These subjects are treated in Part I. as a preliminary to the biological studies.

The map is adapted from Leverett ('99, Pl. VI.); plates XXII. and XXIII. are from photographs belonging to the State Laboratory of Natural History; and the remaining plates are from photographs by Mr. Gleason.

The authors are greatly indebted to Professor S. A. Forbes, Director of the Illinois State Laboratory of Natural History, for his kindly interest and for the publication of this paper; and they desire to acknowledge gratefully the cordial hospitality and assistance of various citizens of Havana and vicinity.

C. A. Hart.

Part I: Glacial Geology and General Characters of the Illinois Sand Areas, especially those of Western Illinois. By Charles A. Hart.

Glacial Geology.

Illinois as a land area has been subjected to at least two principal glacial invasions from the direction of Lake Michigan. the limits of these being roughly concentric with the lower end of this lake. Much of our knowledge of them is derived from the work of Leverett ('99), whose statements, supplemented by my personal observations, form the principal basis of this account.

The earlier of these ice invasions, the Illinoian, apparently much more remote from the later one than this is from the present time, reached about as far west as the Mississippi River, and covered nearly all of Illinois except the northwest corner and the hill country in the extreme south. The later invasion, the Wisconsin, reached about half as far across the state. The heavy deposits of gravel, sand, and clay brought down by these ice-sheets have largely filled up and often entirely obliterated the previous lines of drainage.

The contour of the rock surface beneath these deposits is very imperfectly known, and deserves specific investigation. Records of wells, borings, etc., show, however, that it is deeply carved by immense river valleys of which there are often no surface indications whatever. The great depth of these valleys, usually about one hundred feet below present river levels, does not necessarily indicate a subsidence of this part of the earth, but merely the undisturbed action of water for a vast period of time, or of a greater volume for a lesser period, deepening them to a low gradient nearing base-level, after which the energy of the stream was mostly occupied in widening them.

The Mississippi from Keokuk down and the Illinois below the bend at Hennepin are still in ancient preglacial valleys.

and apparently the entire area of Mason county lies within the boundaries of the latter valley. The highest known point of its rock surface is lower than that of any other county in Illinois, and fifty feet below the present level of the river. Quite probably this county lies in a forking of the preglacial valley, an eastern fork being perhaps indicated by the drainage line now occupied by Sugar Creek and the lower ends of Salt Creek and the Sangamon River, the two latter sections being in a preglacial valley at least four miles wide. Records of wells and coal shafts indicate great valleys beneath Bloomington and Champaign, and another valley leading south from Lake Michigan near the Indiana line, but at present it is impossible to trace these old drainage lines.

In northwestern Illinois the Illinoian invasion evidently caused a radical readjustment of the river systems, turning them westward across adjacent divides into other valleys beyond. (Leverett, '99, Pl. XII.) The buried northward extension of the preglacial Illinois valley above Hennepin is apparently continuous with that of Rock River above Rockford. At a point just below this city the river now leaves its evident preglacial channel, turning westward along side lines of its preglacial tributaries, and is still cutting narrow passages across the rock of the intervening divides. A considerable section of the Mississippi was temporarily crowded over some distance into Iowa, where it has left a fairly well-marked channel that has greatly modified the course of minor streams. It now leaves its great preglacial valley not far below Fulton, Ill., and runs southwest at right angles across the still evident lines of preglacial drainage, which appear to be directed eastwardly and to converge in that direction. In the vicinity of Rock Island the flow of both the Mississippi and Rock rivers seems to be upstream with regard to preglacial lines, in order to cross into another ancient valley at Muscatine. The probability that the preglacial Mississippi channel swings eastward beneath the present lower Rock River valley, and thence across to the bend of the Illinois, is confirmed by the remarkably low sag, especially in rock levels, along this line. In that case, it must have

joined the Rock River somewhere in Bureau county, and the lower Illinois valley was then part of one of the main drainage lines of the continent. The question naturally arises as to the effect of this former relation on geographical distribution. Apparently it had none, since the entire Illinois valley was subsequently covered by the Illinoian glaciation, at which time our river systems were shifted to about their present lines.

The exact rock limits of the preglacial Illinois valley are but imperfectly known. Apparently in obedience to the general law of the westward shift of southward-flowing streams, the present river flood-plain from Peoria down (Pl. V.) follows the west border of the immense valley, never very far from the west bluff, which has a rock core throughout, and exhibits practically all the few rock exposures of the lower valley. Below Meredosia the valley is excavated in limestone strata and is comparatively narrow, usually three or four miles wide, narrowing to a minimum of two and a half miles. From Meredosia up to Beardstown (fifteen miles) it widens out to six miles or more. Above Beardstown the general rock surface was apparently rather low originally and composed of softer strata, and the valley is enormously expanded. The low east bluff is completely concealed by subsequent deposits, yet from the Sangamon to the Mackinaw the original valley is probably not far from twenty miles wide. Above Peoria the limits of the rock valley are largely undetermined, for reasons given further on.

The deposits of the Illinoian glaciation are not very deep. The water action seems to have been moderate, and the surface sand deposits caused by it in Illinois are of little consequence. The larger preglacial valleys, although usually filled with these deposits to a depth of about one hundred feet, are as a rule still traceable, and are usually reoccupied by the main streams, although slight deflections are not uncommon. The terminal ridges pushed up by the ice in this period are now discontinuous, fragmentary, or entirely wanting, although often still prominent and massive. Probably the greater part

of the deposits which now lie between the Illinois valley bluffs over the ancient rock bed are due to the Illinoian glaciation.

The next ice invasion, probably the Iowan, came from the northwest, and to this stage have been assigned deposits in Illinois in the vicinity of the lower Rock River watershed. It seems to have had no marked effect in our state.

Long ages after the close of the Illinoian period, came an event which profoundly affected the future of Illinois, and caused, among other things, the sand deposits studied by us. The Wisconsin glacial invasion was not so extensive as the Illinoian, but it is characterized by voluminous deposits, deeply covering and almost entirely obliterating the previous surface contours; by large and continuous ridges thrown up along the terminal lines and during the successive stages of its retreat; and by abundant and powerful water action. Upon or near the terminal ridges in Illinois are the cities of Princeton, Peoria, Pekin, Atlanta, Clinton, Shelbyville, Mattoon, and Charleston.

A later substage of less extent but even greater intensity was that called the Bloomington, whose terminal ridges branch off eastward near Peoria, and pass under Bloomington and Gibson City, and to the north of Danville, Ill., and Covington, Ind. The enormous outwash of sand and gravel has left more or less of its deposits in all the valleys leading away from these ridges. The west side of the rock valley above Peoria was covered by the terminal ridge to a height, near Peoria, of about 350 feet above the present river, making a total depth of about 450 feet of glacial deposits upon the bottom of the ancient rock valley.

The Illinois, clogged with more than it could carry, filled its bed with sediment to a depth of about 170 feet above present levels at Peoria within the gap in the terminal ridges, and spread out in a vast detrital fan over the great expansion of the valley below, with a comparatively rapid gradient of descent. At the mouth of the Sangamon the filling reached about 75 feet above present levels; and at the river's mouth, about 50 feet. As the ice retreated and the water cleared, nearly all of this vast deposit was swept out of the valley, leav-

ing only a worked-over sandy surface, and, along the valley margins, occasional gravel terraces.

The re-excavated expansion below Peoria is now about twenty miles wide between Pekin and Havana, narrowing gradually below Havana to about twelve miles near the mouth of the Sangamon, and to seven miles at Beardstown, then widening to about twelve miles in western Cass county. At this point the expansion suddenly narrows, and the valley, now in Mississippian limestones, assumes a fairly uniform width of three or four miles. The eastern border of the expansion is indicated by a low bluff, often obscured by subsequent wind action. Teheran, Mason county, lies at the foot of this bluff.

After the ice had retreated from Illinois but still occupied the lower lake-region and St. Lawrence valley, the upper lakes discharged for a time over the low divide at Chicago, along present drainage lines, the valley in this stage of its history being called the Chicago Outlet. The clear and abundant flow excavated the present river flood-plain along the western side of the valley to a depth of fifty to seventy feet below the glacial flood-plain, about thirty feet below its present level. It also spread out to some extent over the glacial flood-plain. Peoria Lake was scooped out in the comparatively narrow opening through the terminal Wisconsin ridges. Leverett ('99, Pl. VI.) has indicated the existence at this time of an eastern channel below Pekin, occupying a depression now approximately followed by the line of the Chicago, Peoria and St. Louis railway from the Mackinaw River below Pekin to Havana. The Mackinaw enters this depression about ten miles south of Pekin, and, turning abruptly northward, reaches the Illinois by way of the upper end of the channel. Quiver Creek enters it near Forest City, and follows it down to the Illinois. The railroad runs along the eastern side of the ancient island included between the two channels. The topography along this line has probably been altered to a considerable extent by wind action upon the loose surface deposits since the formation of the eastern channel. With the establishment of the St. Lawrence drainage the Illinois assumed its present size and position. The lessened flow

in this river, and probably in the Mississippi also, has resulted in a slight and gradual filling, in the Illinois River amounting now to twenty-five or thirty feet.

Topography.

The present lower Illinois River is an inconsiderable stream, normally six hundred to one thousand feet wide, flowing in a belt of very low bottom-land extensively occupied by large swamps, sloughs, and lakes. (Pl. V., VI.) This bottom-land is usually two to four miles in width, narrowest where it passes through the Wisconsin terminal ridges near Peoria and in the narrower part of the valley towards the mouth. Its naturally slow current is still further reduced by the series of government dams, permitting a deposit of soft mud over nearly the entire under-water surface. A few expansions occur, such as Peoria Lake and Havana Lake, respectively a mile and a half-mile wide, but these are shallow, and the river is gradually filling them up and building an enclosed channel down through them. On the other hand, the bottom-lands, although below normal levels for a stream of this size, are so extensive that their general filling up would require a comparatively long period of time. Doubtless under present conditions of the watershed the river is depositing silt vastly more rapidly than it did before the original prairies were broken up and drained for cultivation.

The remaining spaces between this modern flood-plain and the upland bluffs are occupied by the glacial flood-plain or "second bottom," thirty to fifty feet above the river and twenty to forty feet above the lower flood-plain. (Pl. VII.) That portion of this glacial flood-plain which occupies the great expansion of the central part of the lower valley contains the principal sand deposits of the valley, and has been especially studied by us. This lies entirely between the distant low eastern bluffs and the present flood-plain, which closely follows the west bluff. It is about seventy-five miles long, extending from the morainic border below Peoria to the vicinity of Meredosia, Morgan county. It occupies the southwest part of Taze-

well county and extends across nearly the whole of Mason county to the Sangamon, with a maximum width of eighteen miles near the upper end, narrowing southward to about ten miles. The lower part—that below the Sangamon—forms a minor expansion of about half this width in western Cass county and the northwestern corner of Morgan county.

The total area is approximately seven hundred square miles. Except for light superficial deposits its substance is largely sand, which usually reaches to considerable depths. The surface exhibits broad level areas capped by a shallow but rich soil, many of which were originally wet or swampy, but are now drained and cultivated. These alternate with large areas of surface sand—the great sand-bars of the glacial river—drifted by long-continued wind action into irregular, undulating dunes, often barren and desolate, which have traveled northeastward with the prevailing winds. Frequently these dunes form long ridges parallel to the general direction of the valley. Even the bordering uplands are frequently capped with small sand-dunes and ridges which presumably came from the adjacent valley-margin. In drifting with the wind these sand masses have of course overridden to some extent the soil of the level areas, but were probably originally continuous with the underlying sands.

THE SURFACE SANDS.

The surface sand begins at the north with a few narrow strips along the river near Pekin, above the mouth of the Mackinaw. Below this river the sand-covered area is quite large. Only an estimate can be given of its actual extent. The governmental Soil Survey (Bonsteel, '03) reports 22,976 acres of it in southwestern Tazewell county, within a flood-plain area of about eighty square miles, or 51,200 acres. The sand therefore occupies rather more than forty percent of the total flood-plain area in this county. This ratio is doubtless larger in Mason county, which has not yet been examined by the Soil Survey, but accepting it for the entire basin of seven

hundred square miles, it would indicate 179,200 acres, or 280 square miles, of sand.

In an agricultural state like Illinois the economic aspect of such a body of sand becomes of importance. Farm land on the neighboring uplands is valued at $100 to $150 per acre, and yields good crops of corn and oats—the grains most generally cultivated. A considerable part of the sand area also yields excellent grain crops, but in these fields patches of more or less barren or worthless sand often occur. This land is in fact much better adapted to truck crops. Much of the sand is usable only for pasture, and in Mason county alone there are thousands of acres, assessed at a one-fifth valuation of one dollar per acre, which are not used for any purpose. In no other part of central or northern Illinois, except in the larger river-bottoms, are there such extensive tracts of waste land.

The surface configuration, wind action on sand, plant-covering, and similar details of this sand area, are described in connection with the biological studies which follow.

OTHER SAND AREAS.

The remaining sand areas of Illinois are but imperfectly known to me as yet, but a brief statement concerning the principal ones seems desirable.

The presence of sand in the soil is not sufficient to modify the character of the biota until it becomes so abundant as to affect the physical character of the surface and cause it to drift easily with the wind, when it is called blow-sand. When this point is reached, cultivation becomes difficult, and the land is usually left undisturbed even by pasturage. In addition to the biotic change due directly to the excess of sand, the absence of cultivation favors the development of a rich and varied fauna and flora. A large part of the areas usually mapped as sandy do not reach this extreme stage, and are consequently of less interest biologically.

In the large sand area of the expanded middle section of the lower Illinois valley, blow-sand is of frequent occurrence. The upper section, about fifty-five miles in length, lying with-

in the limits of the Wisconsin glaciation, includes but small areas of the glacial flood-plain, and these are not especially sandy, although it is stated (Leverett, '99, p. 267) that there are some dunes capping the eastern bluff-line near the upper end. The lower section, extending from Meredosia to the mouth of the river, about sixty-five miles long, is also narrow, and although the strips of glacial flood-plain are often quite sandy, they are, so far as I know, destitute of blow-sand.

In the Mississippi River valley also, well-developed sand areas of the same general character as the large Illinois River area are similarly present a little farther northward. Large tracts of sand lie on the sag over the supposed preglacial connection between the two rivers, and a similar very sandy glacial flood-plain extends interruptedly along the east side of the valley of the Mississippi, with small dunes capping some of the bordering uplands, from near Burlington, Iowa, up to the vicinity of Savanna, Ill. Blow-sand is known to be present, with all its attendant phenomena, in considerable quantities. The glacial flood-plain along this river is also quite sandy below Burlington over considerable distances, as far as the mouth of the Illinois, but so far as known without true blow-sand development. The blow-sand areas of these two rivers are apparently very similar also in organic life, and evidently should be grouped together.

East of the Illinois River, along the Wisconsin morainic border, especially in eastern Illinois and in adjacent Indiana counties, there is considerable sandy outwash along the rivers, but no definite development of blow-sand is known to me. These sandy strips appear in the Sangamon valley near Niantic, along the Embarras in Cumberland and Jasper counties, and in the Wabash valley near Covington, Ind., and from Terre Haute, Ind., to the mouth of the river, the sand at Covington resulting from the Bloomington glacial substage.

There is an important sand area in northeastern Illinois, with considerable development of blow-sand, derived from the glacial outwash and sand beaches of the upper Kankakee val-

ley. It extends into northwestern Indiana, and is not far distant from the dunes about the south end of Lake Michigan. It is probably similar to these in its plant and animal life, but differs definitely in this respect from the western Illinois areas, judging from published records of collections in the district.

*Part II. A Botanical Survey of the Illinois River Valley Sand Region.**—By Henry Allan Gleason.

Introductory.

The ecological study of sand-dune vegetation has in recent years attracted the attention of numerous American botanists, and many noteworthy contributions to it have been made. Dune vegetation is especially well adapted to ecological investigation, since the changes in the physical factors of the environment are usually considerable, the component associations are sharply distinguished, physiographic processes go on with comparatively great rapidity, and the plant inhabitants show characteristic features in habit and structure. The vegetation of the dunes bordering Lake Michigan has been studied in detail by Cowles, while Rydberg, and Pound and Clements have described the sand-hills of Nebraska. Intermediate in position between these two regions lie the sand deposits now to be considered, and it is hoped that the matter presented may be of some value, not only in the study of sand vegetation in general, but in extending a knowledge of the origin of the prairie flora and of the relation of the forest to the prairie.

The field work upon which this study is based, was carried on during the summers of 1903 and 1904, mainly in the vicinity of Havana, Mason county.

Ecological Factors.

The varying structure and distribution of vegetation are an expression of the various conditions to which it is subjected. Any force or condition, present or past, which has in any way an effect upon vegetation may be termed an ecological factor. The use of this term is, however, more generally restricted to

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those forces or conditions which have or have had direct influence, and among them may be mentioned the historical factors of migration, succession, and the like; the physical factors of water, temperature, and soil; and the biotic factors, including competition, layering, and others. The various factors are by no means independent, but each influences the others and is to some degree influenced by them. The biotic and historical factors are here mentioned either incidentally or under the heading of phytogeography, but the physical factors are in many cases so different from those normal to other parts of Illinois that they are discussed more in detail.

The physical factors which aid in the control of the vegetation of any area have been divided by Schimper ('98, p. 174) into two groups, climatic and edaphic. The climatic factors are temperature and rainfall, and they determine respectively the specific composition of the flora and the general character of the vegetation, whether forest, prairie, or desert. Similar climatic factors are operative over broad areas, and the changes from one type of climate to another are usually very gradual. Local variations in the vegetation are due to the physical or chemical composition of the soil, to its exposure to the sun, to the available supply of water, and to other such factors, designated collectively by the term edaphic. Edaphic factors are always influenced by, and are sometimes the direct result of, the climate. They are also modified to a greater or less extent by the plant-covering, as will be shown later in the discussion of the plant associations.

Although the climate of the Illinois River valley sand region is in every essential respect like that of other parts of central and western Illinois, a strikingly different vegetation has been developed. Receiving the same amounts of heat, light, and rainfall, and exposed to the same winds, the differences in vegetation are due in every case to the sand in its relation to wind, moisture, and available food supply.

The designation Miami fine sand has been applied by the United States Bureau of Soils to the sand composing these extensive deposits along the Illinois River, and the following

description of it is taken from the report of this bureau on the soil survey of Tazewell county (Bonsteel, '03).

"The sand consists of partly rounded grains of quartz stained rusty yellow or orange by iron, and made slightly loamy by the presence of silt or clay. There is no distinction between soil and subsoil. Organic matter is very deficient, as is shown in the following table giving the mechanical analysis of a sample of Miami fine sand from $7\frac{3}{4}$ miles west of Delavan, Tazewell county.

"Organic matter,	0.53%	Fine sand, .25 – .1 mm.,	62.20%
Gravel, 2–1 mm.,	0.10%	Very fine sand, .1–.05mm.,	6.24%
Coarse sand, 1–.5 mm.,	3.92%	Silt, .05–.005 mm.,	2.86%
Medium sand,. 5–.25 mm.,	22.26%	Clay, .005–.0001 mm.,	2.42%"

The soil in the depressions between the sand deposits, known as Miami loam, contains from 1.69% to 2.80% of organic matter, while other soils in the county contain as high as 4.69%.

In every region where large quantities of sand are exposed, the wind plays an exceedingly important part in the ecology of the plant life. Inland it is by no means so active a factor as on or near the shores of large bodies of water, where its velocity is greater and the sand is less protected by a covering of vegetation. Sand blown by the wind may do considerable mechanical injury to the leaves, young stems, and other succulent parts, but as the plants growing in the sand associations are usually adapted to it they are seldom much affected. Growing crops, however, are sometimes badly damaged. The native plant-covering is normally sufficient to prevent much blowing, but if it is any way destroyed, large excavations called blowouts are formed, which, as they increase in size, undermine and destroy most of the vegetation. The sand in these blowouts is so loose and easily disturbed by the wind that only a few species of plants are able to grow in it. The sand removed by the wind is deposited on the leeward side in a fan-shaped heap nearly or quite bare of vegetation (Pl. XII., Fig. 2), or is blown on as a traveling dune. To protect themselves against this shifting of the sand, many plants are especially adapted as sand-binders, and effectually hold the sand in position.

Of far greater importance as an ecological factor is the sand in its relation to the water supply and, indirectly, to the supply of plant food. It is a known fact that coarse soils, such as sands, have a smaller capacity for water than fine soils, the water being held as a thin film surrounding the soil particles, and surface-tension being less effective over large surfaces than over small ones. The water capacity of soils, according to experiments by Schuebler and Wollny (Warming, '96, p. 51), is least in quartz sand. Schimper ('98, p. 94) states that the water which loose sand can hold is but 13.7 percent of its own volume, while clay has a capacity of 40.9 percent. Experiments by the United States Bureau of soils (Whitney and Hosmer, '97, pp. 14–17) on sandy soil in Alabama showed a water content varying from maxima of 11 percent and 14 percent after rains to minima as low as 1 percent and .6 percent during periods of drought. This is in marked contrast with the results of similar experiments on prairie sod in Kansas, where the water content varied from a maximum of 15 percent to a minimum of 7.4 percent, and on blue-grass land in Kentucky, where the average content was over 20 percent, and the line of drought, at which the vegetation began to suffer, was at 15 percent. The actual size of the particles composing these soils is not stated. Warming (*l. c.*) quotes Wollny as saying that the water capacity of quartz sand composed of particles 1–2 mm. in diameter is only one tenth that of sand with particles .01–.07 mm. in diameter. No data are as yet available concerning the actual water capacity of the Miami fine sand in Illinois, but it must be much lower than that of the other soil types of the district.

The power of capillary action to lift water from lower levels is also less in coarse-grained than in fine-grained soils; and in fine sand, according to Ramann (Warming, '96, p. 50), water will rise only 40 centimeters, or about 16 inches, above the surface of the ground-water. In sand with grains from .25 mm. to .1 mm. in diameter, such as constitutes 62 percent of the Miami fine sand in Mason county, water should rise by capillary attraction from 19 to 48 inches. It is evident that no

water could by this means be brought within reach of the smaller plants when the level of the ground-water is twenty feet or more below the surface, as it is in Mason county.

The water-retaining properties of the sand are also of importance to the vegetation. The effect of the percolation of rain water is the saturation of the upper layers of sand to a depth dependent upon the amount of rain. If the surface is dry or only partially saturated, that will first be brought to full saturation, and the surplus water will sink down to lower levels. None is removed by surface drainage, so that, aside from the small quantity remaining attached to plants and other objects, all the rainfall sinks at once into the sand. Evaporation from the surface removes large quantities of water, but according to results obtained by King ('04, p. 159) in North Carolina this is less from sand than from loams or clays. By the drying out of the upper few inches a mulch of loose sand is formed, which still further reduces evaporation. King found that eight ninths of the water which might be expected to evaporate is thus retained, and that during twenty-eight days in July and August, 1902, only .205 in. evaporated from the surface. The climate of central Illinois during the summer is not so different from that of North Carolina as to lead us to expect here any considerable variation from the above record. The moisture in the deeper layers of sand is thus effectually conserved. After a considerable period of drought, as in August, 1894, when only .21 in. of rain had fallen in eighteen days, the sand at a depth of three inches was still moist enough to compact readily in the fingers. Thus, while the actual amount of water present is small, it is nevertheless constant. and it is a common statement of the farmers in Mason county that corn grown upon the sand is less susceptible to drought than that on the more fertile fields of loam. According to Professor J. G. Mosier, of the Illinois Agricultural Experiment Station, the "firing" of corn on the sand is due to a deficiency of plant food and not to lack of water. Some interesting cases of other soil types, having similar but more marked powers of water conservation, are reported by Whitney ('98).

He describes soils in California which can mature crops without any rain during the growing season, and without irrigation.

All the water held in the soil by capillary action is not available for plants, but the percentage which can be absorbed is greater in coarse-grained soils, like sand, than in those of finer texture. Experiments by Sachs showed that in a clay with a water capacity of 52.1 percent, only 44.1 percent could be used by a tobacco plant, leaving 8 percent of unavailable water; while in a sand with 20.8 percent water capacity, 19.3 percent, very nearly the whole amount present, was available. These results are substantiated in the field, plants suffering from drought in some soils with 15 percent water, while in others, of more sandy nature, they are still healthy with a water content of less than 5 percent.

In contrast with the foregoing data mention should be made of the experiments of Livingston and Jensen ('04), who have shown that the fertility of the soil is dependent on the size of the component particles, and that coarseness alone "can produce sterility in spite of a plentiful supply of water." It is entirely possible, then, that the mere size of the sand particles may be an important ecological factor in the sand region along the Illinois River.

But independently of the quantity of water present in the sand, the precipitation must have a marked bearing on the quantity and kind of available plant food. In all the sand region, as before stated, there is no surface drainage. Water falling as rain sinks at once into the sand, and the excess is removed by underground drainage to the Illinois River, where it issues through countless springs along the east bank. After the heaviest rains, water may collect for a time in the blowouts and interdunal depressions, but it soon sinks into the sand. By this rapid percolation through the upper layers of sand much of the soluble matter must be dissolved and carried down to the level of the ground-water, which in this region is never less than twenty feet below the surface (Leverett, '96, p. 759;

'99, p. 688), and on the higher sand-hills is certainly much lower. It is here beyond the reach of all plants except the larger trees, and they, too, must be able to live in the poorer surface sand until their roots have penetrated nearly to the level of the ground-water.

The importance of the relation of food supply to vegetation has probably been greatly underestimated, while too much stress has been placed on the water supply and the physical condition of the soil. Whitney and Cameron ('03) have even declared that all ordinary soils contain plant food sufficient for the growth of crops, and this may well be so in a soil containing relatively large amounts of calcium, potassium, magnesium, and phosphorus, even though little may be available at any one time; but in a sand composed in very large proportion of silica, the leaching action of the rainfall must ultimately tend toward the exhaustion of the plant food, leaving a residue of silica and other insoluble substances. Such has been found the case in various places. Livingston ('05, p. 26) has remarked upon the low content of soluble salts in some sands in northern Michigan. Graebner ('01, p. 64) has discussed the leaching action of rain on the sandy soils in Germany, and decides that the formation of heaths there is due in great part to the insufficient supply of plant food. No full determinations of the soluble matter in the Miami fine sand have as yet been made, but, according to Professor Mosier, this sand is deficient in plant food of all kinds. The relative height of plants growing in Mason county on sand and on loam soils, certainly indicates a scarcity of plant food in the former. Indian corn tassels on the sand at a height of three to four feet; *Monarda punctata* is usually little over a foot high; and many other species are conspicuously below the size reached in the neighboring woods and on the prairies.

Unfortunately none of the foregoing theories has been tested by actual experiment on sand plants in the region under discussion, and until more definite knowledge is available, one can only believe that in general the supply of food matter

and the physical properties of the sand, including the size of the particles and to some extent the water content, are both of importance, and by their combined effect determine the peculiar type of vegetation. Direct observation alone, however, is sufficient to show that the water supply on the dunes is reasonably constant, and the plants owe their xerophytic habit to the rapid loss of water by transpiration, and not to a deficient soil content.

The climate in these sand regions is of course similar to that of the surrounding parts of the state, and has no direct influence in causing the marked differences in vegetation. Nevertheless, temperature is of importance in determining the flora of any region, and the mixed prairie and forest type of vegetation of central and northern Illinois is to some extent the result of the seasonal distribution of rainfall. For these reasons, as well as to show the general climatic conditions of the area under discussion, tables showing the precipitation and temperature are included. The data are taken from Mosier's "Climate of Illinois", and are given for Havana so far as observations at that place are available. The records are also given for Peoria and Springfield, Illinois, and for Keokuk, Iowa, three cities forming a triangle, with Havana and the sand region in its approximate center. It should be noted that the temperature readings are taken under the regular shelters used by the U. S. Weather Bureau, and consequently do not represent the degree of heat to which plants are normally subjected.

Monthly and Annual Mean Temperature.

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Havana....	27.8	27.7	39.9	53.4	63.8	74.2	77.5	75.9	69.0	57.8	40.8	31.5	53.3
Keokuk...	24.7	24.0	37.5	52.5	59.9	72.4	78.6	74.6	66.7	55.0	39.2	26.4	50.9
Peoria	24.6	27.3	38.7	53.4	63.6	74.3	78.3	74.8	67.3	54.4	39.8	30.7	50.8
Springfield	26.4	29.4	39.2	53.4	63.1	72.0	76.4	73.9	66.8	56.7	41.4	32.0	52.5

The average annual range of temperature in the central district of Illinois is 109°, while the extreme range is 140°, from — 28° in January, 1884, to 112° in July, 1901. The average

range in summer is 50°, but no data are available showing the daily range. The average date in the central district for the last killing frost in spring is April 21, and for the first in autumn, October 10, thus including a growing season of 172 days.

MEAN MONTHLY AND ANNUAL RAINFALL.

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Havana...	2.21	2.17	3.06	3.07	3.75	3.23	3.81	3.08	3.44	1.19	2.18	1.89	33.08
Keokuk...	1.72	1.64	2.30	3.18	4.41	4.37	4.33	3.06	3.68	2.66	1.98	1.63	34.96
Peoria.....	1.73	1.93	2.51	3.01	3.80	4.01	3.44	2 88	3.57	2.26	2.63	2.21	33.98
Springfield	2.26	3.16	3.03	3.22	4.76	4.45	2.64	2.67	3.56	2.57	2.94	2.43	36.69

The amount of rainfall in this same district during the growing season, assuming that to be from April to September inclusive, is at Springfield 60.8 percent, at Havana 61.6 percent, at Peoria 63.6 percent, and at Keokuk 66.0 percent. At Cairo, at the extreme southern end of the state, only 48.4 percent of the total rainfall occurs during this period. There is thus seen in central Illinois a resemblance, increasing toward the west, to the type of rainfall found on the western prairies, where as much as 80 percent of the total falls during the growing season. This unequal seasonal distribution is an important factor in determining the prairie type of vegetation in the West, and is certainly not without some influence in directing the eastward migration of the prairie flora.

THE PLANT ASSOCIATIONS.

The plant associations occurring in this region belong to both of the prevailing types of vegetation in the state, the forest and the prairie. They may be classified as follows:

I. The prairie formation.
   1. The bunch-grass association.
   2. The blow-sand association.
   3. The blowout association.

II. The forest formation.
   4. The black-jack oak association.

It is difficult to estimate the relative areas occupied by the two formations, although the impression gained by traveling

across the country, by rail and on foot, is that the two are about equal in extent.

THE BUNCH-GRASS ASSOCIATION.

Through the prairie formation the bunch-grass association is the prevailing one, covering alike the level areas of sand and the dunes, and broken only by cultivated fields or by blowouts and blow-sand. The association derives its name from, and is characterized by, several species of grasses which grow in compact stools or bunches varying from a foot to two feet in diameter. They are not crowded so closely as to produce a sod, as in the typical Illinois prairies, but stand a little distance apart, thus making the bunch character prominent (Pl. XVIII., Fig. 1). There is but little of the bunch-grass prairie remaining in its original state, most of it having been pastured with horses or cattle, which by their grazing have greatly changed the character of the vegetation. Southeast of Bath there is a field which has apparently never been pastured (Pl. VIII., IX.), and the following description of the original type of bunch-grass prairie is based on its character there and on small strips along the railroads.

The principal grasses are *Eragrostis trichodes*, *Stipa spartea*, *Panicum cognatum*, and an undetermined species of *Panicum*. The first two species produce large loose bunches, one to two feet in diameter and almost as high, with the culms rising to a height of three to five feet. *Panicum cognatum* grows in dense flat bunches scarcely a foot high, exclusive of the widely spreading panicles, and the undetermined *Panicum* is even lower, with the basal leaves and culms almost prostrate. *Tricuspis seslerioides*, with loose bunches much like those of *Eragrostis trichodes*, is abundant in some places, especially near the edge of timber; *Calamovilfa longifolia*, with culms six feet high, occurs sparingly in patches; and *Eragrostis pectinacea*, *Bouteloua hirsuta*, *Panicum virgatum*, *Paspalum setaceum*, and *Sporobolus cryptandrus* also produce more or less well-developed bunches. *Carex gravida* and *Cyperus Schweinitzii* have tufts of basal leaves from which several culms arise, and may also be grouped with the

bunch-formers. Three other grasses, *Syntherisma filiformis*, *Aristida tuberculosa*, and *Cenchrus tribuloides*, and two sedges, *Cyperus Bushii* and *C. filiculmis*, are abundant, but do not form bunches.

The distribution of the remaining members of the association, about fifty in number, is very irregular, and a group of representative species can not be chosen from them. *Rosa humilis*, *Solidago missouriensis*, *Amorpha canescens*, *Opuntia humifusa*, *Callirrhoe triangulata*, and *Monarda punctata* are the most conspicuous, but as the quantitative study of the plants shows, not so numerous as *Teucrium canadense*, or *Ambrosia psilostachya*. With the exception of *Monarda punctata* and the last two species, these grow in rather dense, rounded patches. The same is true to a lesser extent of almost every other species in this class, but since the individuals are smaller or less abundant, many other species may be included, or two or more patches, each with traceable outlines, may overlap. If the plants are at all conspicuous the overlapping is plainly seen, and in any case it is brought out by quantitative study of the area. This form of distribution is characteristic of associations where there are no progressive changes in any of the ecological factors, and consequently no zonal arrangement of the plants. Annuals with limited means of seed dispersal, and perennials spreading by rootstocks or runners, naturally grow in rounded patches under those conditions. It is evident, then, that while the bunch-grasses are representative, the other species, of merely local distribution, are to be considered as secondary members of the association.

Table I. shows the distribution of the species in a piece of original bunch-grass prairie. The letters after each name here and in subsequent tables, indicate the number of individuals, if any, in one quadrat of one hundred square feet, *a* signifying 1 to 5; *b*, 5–10; *c*, 10–25; *d*, 25–50; *e*, 50–100; *f*, 100–200; *g*, over 200; and *o*, none. These counts were estimated for the most part, although care was taken to make actual counts at intervals in order to avoid so far as possible any serious errors of observation. The quadrats in this table, as well as in all the oth-

er tables, were side by side, in this instance extending in a strip 110 feet long by 10 feet wide. Near the area covered by these quadrats, but not included in them, were patches of *Solidago missouriensis* (*c*) and *Rosa humilis* (*e*); *c* and *e*, as above defined, indicating their respective numbers per quadrat.

TABLE I. ORIGINAL BUNCH-GRASS PRAIRIE.

Eragrostis trichodes	d*	d	d	d	d	d	c	c	c	c	c
Panicum cognatum	c	c	c	c	d	c	d	d	d	d	e
Panicum sp.	o	a	b	c	a	b	b	c	c	c	b
Ambrosia psilostachya	e	e	e	c	d	d	e	d	c	e	c
Teucrium canadense	c	b	c	e	e	e	e	e	d	d	f
Leptilon canadense	c	b	o	b	e	e	c	b	c	o	b
Monarda punctata	a	a	a	a	a	a	b	a	o	a	b
Cassia chamæcrista	a	a	o	a	o	a	a	a	a	o	a
Opuntia humifusa	o	o	o	o	b	a	b	c	c	c	a
Lespedeza capitata	a	o	a	o	a	o	a	o	o	o	b
Cyperus Schweinitzii	a	a	o	a	o	a	b	a	o	o	o
Crotonopsis linearis	o	a	o	a	o	o	a	o	c	c	o
Croton glandulosus	o	o	o	o	a	b	o	a	a	o	o
Commelina virginica	o	o	o	o	o	o	a	a	o	b	a
Aristida tuberculosa	o	o	a	a	o	o	o	o	a	o	o
Cyperus filiculmis	o	o	o	o	o	o	o	o	a	b	a
Froelichia campestris	o	a	o	o	o	o	o	o	o	o	o
Œnothera rhombipetala	o	o	o	o	o	o	a	o	o	o	o
Lactuca canadensis	o	o	o	o	o	o	o	o	o	o	a
Chrysopsis camporum	o	o	a	o	o	o	o	o	o	o	o

In this instance it will be seen that *Eragrostis trichodes* was the most prominent bunch-grass. That is not always so, but its place is frequently taken by other species. For example, near this survey was another tract of undisturbed bunch-grass composed of *Carex gravida* and the undetermined *Panicum*, with an abundance index of *c* and *g*, respectively, per quadrat.

* See p. 159.

Grazing results in the destruction of the larger species of bunch-formers, leaving *Panicum cognatum* and the undetermined *Panicum*, *Paspalum setaceum*, and *Bouteloua hirsuta* as the predominant grasses. The other species, such as *Eragrostis trichodes* and *Stipa spartea*, so prominent in the original vegetation, are present only rarely and in scattered bunches. The

TABLE II. PASTURED BUNCH-GRASS.
(Not pastured for two years preceding count.)

Bouteloua hirsuta	a*	f	f	f	e	d	c	o	c	c
Panicum cognatum	e	c	a	o	o	o	o	o	o	o
Panicum sp.	b	c	c	b	d	d	o	d	b	o
Paspalum setaceum	c	a	a	b	d	b	o	a	e	f
Opuntia humifusa	a	c	b	c	c	b	c	b	a	a
Leptilon canadense	b	b	c	o	c	g	e	e	d	b
Ambrosia psilostachya	c	b	a	b	d	e	e	f	d	c
Monarda punctata	a	c	o	a	o	a	b	c	b	c
Cassia chamæcrista	a	a	a	o	o	a	a	b	a	o
Petalostemon candidus	a	b	b	a	a	a	o	o	o	o
Carex gravida	o	b	o	o	a	b	a	c	a	o
Eragrostis trichodes	o	o	b	c	a	a	a	a	o	o
Ionactis linariifolius	a	a	b	b	a	a	o	o	o	o
Polygala verticillata	o	b	a	a	a	a	o	o	o	o
Cyperus Schweinitzii	a	a	o	a	o	o	o	o	a	o
Crotonopsis linearis	c	o	o	o	o	o	o	a	c	o
Poa pratensis	o	o	a	a	o	o	a	o	o	o
Polygonum tenue	c	o	a	o	o	o	o	o	o	o
Commelina virginica	a	a	o	o	o	o	o	o	o	o
Croton glandulosus	o	o	o	o	o	o	o	a	o	a
Chrysopsis camporum	o	o	o	o	o	o	o	o	o	b
Lithospermum linearifolium	o	o	o	o	o	o	o	a	o	o
Callirrhoë triangulata	a	o	o	o	o	o	o	o	o	o
Phlox bifida	o	o	o	o	o	o	a	o	o	o

*See p. 159.

four predominant species are all small, and produce low flat bunches, giving the association an appearance widely different from the original. The sedges, especially *Cyperus Schweinitzii* and *Carex gravida* still persist, almost as abundantly as before. Certain other species are much more abundant, such as *Monarda punctata*, *Cassia chamæcrista*, and *Opuntia humifusa*, as well as the less important *Polygonum tenue*, *Crotonopsis glandulosa*, and *Polygala verticillata*. *Leptilon canadense* and *Ambrosia psilostachya* are usually very abundant, but on account of their slender habit are not very conspicuous. *Euphorbia Geyeri*, more characteristic of blow-sand, is in some places common, and *Chrysopsis camporum*, *Froelichia campestris*, *Œnothera rhombipetala*, *Croton glandulosus*, *Lespedeza capitata*, *Lithospermum linearifolium*, and *Commelina virginica* are well distributed, but seldom plentiful.

Table II. shows the composition of the vegetation of a pastured bunch-grass prairie, which, however, has not been in pasture for two years preceding. The first quadrat is near the foot of a dune, and the survey ran up the dune, ending near its top.

Table III. gives the results of a survey of a field which has been used for pasture for several years. The bunch-grass has been largely destroyed, and is replaced by *Opuntia*, *Ambrosia*, and *Leptilon*.

THE BLOW-SAND ASSOCIATION.

The bunch-grass prairie, while of a more or less permanent nature, is in no sense a climax association, but may be modified, through the action of certain physical factors on the one hand and of biotic factors on the other, along two definite and distinct lines, culminating in two widely different plant associations. In the first case the wind is the principal factor, and primarily through its influence the bunch-grass association is changed into blow-sand and blowout associations and ultimately into a prairie. In the second case, biotic factors are of chief importance, and the prairie is finally succeeded by the black-jack forest, representing an entirely distinct formation.

Wherever considerable bodies of sand occur, the wind

plays a prominent part in determining the physiography, causing migrating dunes and blowouts, where the sand shifts so readily that it remains entirely without vegetation (Pl. XII., Fig. 1), or is colonized only by those few species able to adapt themselves to the peculiar ecological conditions (Pl. XIII.). Some resistance to the wind action is usually offered by the vegetation, so that the area occupied by the blow-sand is lim-

TABLE III. PASTURED BUNCH-GRASS.

(In pasture up to time of count.)

Paspalum setaceum	a*	a	a	c	a	a	c	c	c	b
Panicum cognatum	o	a	c	a	a	b	o	a	o	b
Bouteloua hirsuta	o	a	o	o	o	b	b	o	o	o
Opuntia humifusa	b	a	c	b	b	b	b	o	o	a
Ambrosia psilostachya	g	f	f	e	e	f	e	b	f	f
Leptilon canadense	g	f	f	a	f	d	c	o	o	o
Monarda punctata	a	a	c	a	b	b	a	a	b	b
Cassia chamæcrista	a	o	a	d	b	a	a	a	a	a
Œnothera rhombipetala	a	o	a	a	a	a	o	o	a	a
Euphorbia Geyeri	o	o	a	a	o	a	b	c	c	a
Croton glandulosus	o	o	a	a	a	a	a	a	a	o
Froelichia campestris	o	o	a	a	o	o	a	o	o	a
Commelina virginica	o	a	a	o	o	o	o	a	o	o
Chrysopsis camporum	o	o	a	a	o	o	o	o	o	o
Cyperus Schweinitzii	o	o	a	o	o	o	o	o	o	o
Cenchrus tribuloides	o	o	o	o	o	o	o	o	o	a
Lespedeza capitata	o	o	o	o	o	o	o	a	o	o

ited. In the present case the covering of bunch-grasses, with their fibrous roots, and of such other sand-binding plants as the matlike *Opuntia*, or the dense clumps of *Amorpha canescens* or *Chrysopsis camporum*, is very effectual. Blowing still takes place, as is shown by the slight excavations between the bunches on the hilltops (Pl. XIV., Fig. 2), but it results merely in a general redistribution of the sand, the quantity removed being vir-

* See p. 159.

tually balanced by that deposited, and the whole remaining approximately in a state of equilibrium. On the crests of the dunes, however, where the sand is more exposed to the wind and more is blown away than is deposited, the plants are frequently separated by shallow excavations, and may sometimes be uprooted entirely, thereby permitting the free action of the wind, and leading to the formation of a blowout. In fields that have been pastured, there is frequently a black crust an inch or so deep formed over the surface, probably by the decay of the grass and leaves trampled into the sand by cattle. In dry weather this crust is quite hard, and effectually checks the shifting of the sand.

The resistance offered by the vegetation is, indeed, very effectual, and some old settlers say that there were no blowouts in the sand region in the middle of the last century, when settlements were first begun, but that they have all been formed since then. The report of the Illinois Geological Survey published in 1870 does not mention them, and it is improbable that such conspicuous blowouts as exist to-day could have escaped the attention of the State Geologist, who traveled over the country on horseback. There are, however, a few large fields of blowouts and blow-sand that have been in existence as long as the neighboring residents can remember, such as the Devil's Neck (Pl. XII., Fig. 1; XIV., Fig. 1), north of Topeka, where a field of about eighty acres is entirely covered with blow-sand.

Plowing is generally believed to be the cause of the formation of blowouts, the natural vegetation being thus destroyed, and the sand left exposed to the winds of winter and spring after the cultivated crops are removed. All of the Miami loam between the sand deposits is under cultivation, and the frequent efforts of the farmers to extend their fields upon the dunes have often led to disastrous results. Adjacent fields of fertile soil are known to have been ruined in that way (Pl. XI.), and at present most farmers let the sand stand unused, or use it for pasture only. It is also said that cattle may destroy the vegetation, and that blowouts may be started in this way.

When the protective covering of vegetation is once broken,

by whatever means, blowing proceeds rapidly, resulting in the saucer- or bowl-shaped excavations known as blowouts (Pl. VIII., IX., XV.). Their depth may finally be as great as the depth of the sand itself, and their area is sometimes several acres in extent. Their sides usually have a gentle slope, but are sometimes quite steep where the bunch-grass along the crest has restricted the blowing (Pl. XIV., Fig. 2). The sand removed from the blowouts is piled up on the leeward side in a more or less fan-shaped heap, and this in turn is blown on by the wind as a traveling dune (Pl. XII., Fig. 2). Blowouts may be partially or wholly refilled by sand, being thus transformed into level tracts (Pl. XIII.), generally called blow-sand, and when these become large the individual blowouts lose their identity and the whole tract becomes a vast undulating surface of shifting sand. The limit of size is reached when the blowout becomes so large that it no longer offers much resistance to the wind, or so deep that the wind does not have sufficient force to carry the sand from the bottom up over the sides, or when moister layers of sand are reached which can not be blown.

In young blowouts, when the excavation is being carried on most rapidly, vegetation is very sparse, and the few species able to grow in such conditions constitute the typical blow-sand association. They are mostly plants with a short period of development, which may mature before the shifting of the sand has undermined their root-system, and they frequently possess methods of seed distribution by which they are enabled to colonize rapidly on barren areas of sand. The most characteristic species are *Ambrosia psilostachya*, *Cassia chamaecrista*, *Cenchrus tribuloides*, *Cycloloma atriplicifolium*, *Cristatella Jamesii*, and *Aristida tuberculosa*. Of these, *Cassia* and *Cenchrus* are the most abundant. Six to ten thousand plants of *Cenchrus*, none of them more than six inches high, sometimes grow on a single quadrat ten feet square, and a third of them produce seeds. *Cassia* prefers sand that is loose from blowing or that has been otherwise disturbed. Wagon tracks across the sand are quickly occupied by it, and are marked by long parallel lines of the plants, which are very conspicuous in the blooming season.

Cassia, however, can not grow upon such rapidly shifting sand as *Cenchrus* can, and both are surpassed in this by *Cycloloma atriplicifolium*. *Cristatella Jamesii* is absolutely confined to blow-sand (Pl. XX., Fig. 1), and disappears when the blowing is stopped.

Numerous other species may occur, such as *Croton glandulosus, Euphorbia Geyeri, Ambrosia psilostachya, Sporobolus cryptandrus, Mollugo verticillata*, and *Acerates viridiflora*. Others, less abundant, are usually relics of the bunch-grass association, the original occupant of the territory, which have persisted because their sand-binding adaptations have prevented their being undermined and blown away.

Blowouts of any age may be filled up and converted into level stretches of blow-sand, covered with the blow-sand association already described, but with more *Cycloloma* and less *Cassia* in the older ones. The vegetation is always sparse, and the blowing of the sand during the fall and winter is sufficient to prevent the perennials of the bunch-grass association from gaining a foothold. Over wide stretches of blow-sand there is frequently absolutely no vegetation, while on others there is nothing but *Cycloloma, Ambrosia, Cassia*, and *Cenchrus*.

Counts in a developing blowout and in a few typical areas of blow-sand are here given.

TABLE IV. SMALL BLOWOUT.

Cassia chamæcrista	f*	f	e	d	d	d
Ambrosia psilostachya	e	e	e	d	d	f
Cenchrus tribuloides	e	e	d	e	d	g
Cristatella Jamesii	o	a	b	c	c	e
Froelichia campestris	o	a	o	a	a	a
Euphorbia Geyeri	o	b	o	c	c	b
Lithospermum linearifolium	o	c	b	b	b	o
Cyperus Schweinitzii	o	o	b	o	b	o
Cycloloma atriplicifolium	o	o	o	o	a	a
Monarda punctata	a	o	o	a	o	o

* See p. 159.

TABLE V. BLOW-SAND.

Cycloloma atriplicifolium	d*	d	c	c	c
Cassia chamæcrista	a	o	b	o	o
Euphorbia Geyeri	o	a	o	a	a
Cenchrus tribuloides	b	o	o	o	o
Commelina virginica	o	a	o	o	o

TABLE VI. BLOW-SAND.

Cassia chamæcrista	g*	f	b	o	o
Ambrosia psilostachya	e	e	d	o	o
Euphorbia Geyeri	c	d	b	o	o
Commelina virginica	a	a	o	a	o
Cenchrus tribuloides	e	a	o	o	o
Croton glandulosus	a	o	o	o	o
Cristatella Jamesii	a	o	o	o	o

TABLE VII. BLOW-SAND.

Cycloloma atriplicifolium	f*	f	g	a	f
Cassia chamæcrista	c	e	g	g	f
Ambrosia psilostachya	f	e	e	e	c
Cenchrus tribuloides	o	o	o	o	a

THE BLOWOUT ASSOCIATION.

When the excavation of the blowout has proceeded so far that the maximum depth is reached, the blowout association is developed at the bottom, in response to the changed ecological conditions. These are (1) a slight protection from the wind, (2) a more stable substratum, and (3) a larger supply of soil moisture. The result is an association essentially mesophytic in nature. Most of the members of the blow-sand association, excepting *Cycloloma* and *Cristatella*, persist for a time,

* See p. 159.

and numerous species of the bunch-grass may also spring up, but a new group of species appears, and by their predominance the aspect of the vegetation is entirely changed (Pl. XV.).

Among the first to appear is *Stenophyllus capillaris*, which grows in a carpet over the flat bottom of the blowout, but never extends up the sloping sides. Its growth soon results in the formation of a thin layer of black humus over the surface. Associated with it usually are large clumps of *Panicum virgatum* and *Sorghastrum avenaceum*. These grasses are typical plants of damp blowouts and interdunal depressions, but retain their place even when the blowout is subsequently covered by blow-sand. *Andropogon furcatus*, another grass common on the black-soil prairies, is frequent, and with these herbaceous species are often associated a number of woody forms not found at all in the bunch-grass prairie or in the black-jack timber. These are *Vitis vulpina*, *Menispermum canadense*, *Populus deltoides* (Pl. IX.), and *Acer Negundo* (Pl. XVII.). All of these have effective methods of seed dispersal, and are probably disseminated widely over the sand area, but are able to effect ecesis only in these more favorable conditions. The two vines scramble over the ground, but the trees grow rapidly and, like the grasses above mentioned, persist even when the blowout is refilled with sand. The past history and position of the blowouts are frequently shown by a large cottonwood or box-elder tree, buried in sand to its lower branches. Two species of *Cladonia* soon appear, and are active as soil formers. They are not restricted to the very wettest part, as is *Stenophyllus*, but extend out upon the naked sand, and also occur in shallower blowouts which have never reached a condition suitable for the sedge. Following the *Cladoniae* are *Antennaria* sp. and *Helianthus occidentalis*, and, a little later, such other species as *Hieracium longipilum*, *Helianthus scaberrimus*, *Meibomia canadensis*, *Lacinaria scariosa*, *Mesadenia atriplicifolia*, and others common on the black-soil prairies, and the association is converted into prairie scarcely distinguishable, in vegetation at least (Pl. XVII.), from the typical prairies of central Illinois.

A blowout succession is therefore as follows:

1. *Cassia—Ambrosia—Cycloloma* (Blow-sand association)
2. *Stenophyllus—Panicum—Sorghastrum* } (Blowout association)
(2a. *Populus—Acer*)
3. *Cladonia—Antennaria* } (Prairie association)
4. *Helianthus—Hieracium*

It is in only a small proportion of the numerous blowouts that this succession is followed to the culmination in a prairie. In fact, only one was observed that had reached the stage numbered 4. Probably not more than a tenth ever reach stage 2.

Although the wind alone is instrumental in the excavation of the blowouts, it has in general a leveling action. The sand removed from each blowout is distributed over a larger area than that from which it was taken, so that the tendency of the wind action is toward a level surface of sand.

Reversion to Bunch-grass.

It has just been shown that in certain cases the blowout association may develop into one of the prairie associations. Similarly, if for any reason the blowing of the sand ceases, recolonization is begun by the bunch-grass association. Naturally the species most active in this are those members of the bunch-grass association that are able to live on blow-sand, and particularly the sand-binder *Sporobolus cryptandrus* (Pl. XVIII., Fig. 2). The bunch-grasses themselves are among the last to appear, and their place is previously filled by *Callirrhoe triangulata*, *Rhus aromatica*, *Chrysopsis camporum*, and other sand-binders, or sometimes even by the Kentucky blue-grass, *Poa pratensis*. Two stages in the regeneration of the bunch-grass are shown in the following tables.

Even after the sand is completely fixed, the bunch-forming grasses are much less abundant than in the normal association, their places being filled by *Chrysopsis camporum*, *Opuntia humifusa*, *Callirrhoe triangulata*, and *Rhus aromatica*.

The blowouts may be fixed without first filling up with blow-sand, and in this case they are occupied directly by the species of the bunch-grass association, which extend down into it, and ultimately occupy it completely. The stools growing

near the crest of an active blowout are constantly being undermined, and slide down with the loose sand towards the bottom (Pl. XVI.). They are not killed directly by this, but are frequently seen alive near the bottom, and in this way are directly available in holding the sand.

TABLE VIII. BLOW SAND.

(Fixation just begun.)

Sporobolis cryptandrus	d*	d	d	c	d
Chrysopsis camporum	d	d	c	d	d
Cassia chamæcrista	d	c	a	c	c
Ambrosia psilostachya	c	d	c	d	d
Monarda punctata	o	o	o	a	a
Euphorbia Geyeri	d	o	o	o	o
Cyperus Bushii	o	o	o	o	a
Paspalum setaceum	o	o	a	o	o
Commelina virginica	o	o	o	o	a

TABLE IX. BLOW-SAND.

(Nearly fixed.)

Sporobolus cryptandrus	e*	e	d	d	e
Chrysopsis camporum	d	c	c	d	d
Lespedeza capitata	c	c	c	b	a
Ambrosia psilostachya	b	c	c	b	o
Cyperus Schweinitzii	o	a	a	a	b
Monarda punctata	o	a	a	a	a
Paspalum setaceum	o	o	a	o	o
Aristida tuberculosa	o	o	o	b	b
Croton glandulosus	a	o	o	o	o
Leptilon canadense	o	a	o	o	o

But one other result of the movement of the sand remains to be considered, and that is the effect of the blow-sand on the

* See p. 159.

vegetation which it covers. Small trees are usually killed, but larger ones will withstand burying to a considerable depth. Frequently the only sign indicating the former position of a blowout is a cottonwood tree (Pl. IX.) buried to its lower limbs, but still alive. Walnut, butternut (Pl. X.), box-elder, and hackberry have also been observed partially buried in the same manner. The vegetation of the front of a dune which has reached such a grove (Pl. XX., Fig. 2) is quite different from that of a dune advancing in the open. The sand, shaded and protected from evaporation, is much moister in the upper layers, and the face of the dune is at a steeper slope. The herbaceous vegetation is sparse, probably because of the weak light, since in the sunnier spots the individual plants are more numerous. The principal species are *Solanum nigrum*, *Euphorbia heterophylla*, *Sicyos angulatus*, *Clematis Simsii*, *Parthenocissus quinquefolia*, *Menispermum canadense*, *Ribes missouriense*, *Allionia nyctaginea*, *Vitis riparia*, *Campanula americana*, and *Urticastrum divaricatum*. The same species occur in the valleys of the Miami loam below. Near the top various photophile forms, such as *Cenchrus tribuloides*, *Monarda punctata*, and *Asclepias syriaca*, appear in great abundance. The three first-mentioned species are evidently pronounced mesophytes, as specimens wilt very rapidly when pulled. Nevertheless, the *Solanum* is finely pubescent, while the usual mesophytic form in loamy soil is nearly always glabrous.

To summarize the preceding statements concerning the development of plant associations from the bunch-grass, the action of the wind may lead to the development of the blow-sand and the blowout associations, but either of them may normally revert to the bunch-grass association unless the blowout excavation has continued until most of the sand is removed, when a normal black-soil prairie ensues.

THE BLACK-JACK ASSOCIATION.

Throughout the central part of the state the prairie represents the most primitive plant formation. It has been shown that in the sand region,—and the same holds true throughout

central Illinois,—variations in local conditions may produce minor changes in the plant-covering, but that the resulting subsidiary associations revert in every case to the typical bunch-grass prairie. The great extent of the prairie formation, the aggressiveness with which it displaces the minor associations within it, and the resistance which it offers to the encroachments of the forest, characterize it as a temporary climax type of vegetation. That the prairie of Illinois is, however, being rapidly displaced by the forest is no longer a matter of doubt. Cowles ('01) has shown that for the Chicago district the culminating, or climax, type of vegetation is the mesophytic forest. While a similar mesophile association is the climax for the central part of the state, the intermediate stages here may be very different on account of differences in the physiography or in the biotic environment.

In the typical Illinois prairies the encroachment of the forest upon the prairie progresses along the drainage lines. The prairie soil always contains a sufficient amount of humus for the growth of many species of forest plants, and the succession of associations is hastened by the changes in soil and topography due to stream action. The more permanent supply of soil-moisture along the streams is a condition not found on the prairie, and this constitutes a weakness at the most critical point of its defense. In this sand region none of these favorable conditions is found. There is no humus in the sand, and there is no surface drainage, and consequently no erosion, no base-leveling, and no increased water supply,—all of which in other places so facilitate the extension of the forest.

The first tree-growth that invades the sand prairies is a xerophytic association composed mainly of the black-jack oak, *Quercus marylandica*, and usually known as black-jack timber (Pl. XXI., Fig.1). The almost complete absence of water-courses prevents its extension in long belts paralleling streams, and, instead, it is found in large masses, with more or less rounded outlines, on the larger sand deposits, or in narrow strips following the dunes. It is limited entirely to the sand, never invading the more fertile fields of Miami loam, nor en-

croaching upon the bottoms of the Illinois River. Besides the black-jack oak, which constitutes, by rough estimate, fifty percent of the forest, there is about thirty-five percent of black oak, *Quercus velutina*, and fifteen percent of hickory, *Hicoria microcarpa*. These three are the only arborescent species of the black-jack timber, and in some places but one of them (*Quercus marylandica*) is present. The trees seldom exceed a foot in diameter, and they are generally very crooked, gnarly, and full of dead branches. The hickory is nearly always sterile, only the very largest trees producing fruit. The underbrush consists mainly of young trees of hickory and the two oaks, with occasional clumps of *Rhus aromatica*. Other shrubby species of less prominence occur, such as *Amorpha canescens* and *Salix tristis*. Since the ecology of the black-jack association, at least during its early stages, differs from that of the original bunch-grass association only in the smaller amount of light received by its plants, the herbaceous and shrubby flora of the two are very similar. Of the species observed on the prairie, all but thirteen were also found in the black-jack forest. These were *Spartina cynosuroides, Stipa spartea, Calamovilfa longifolia, Stenophyllus capillaris, Populus deltoides, Acer Negundo, Cristatella Jamesii, Populus dilatata, Gleditsia triacanthos, Lesquerella spathulata, Acerates viridiflora, Hieracium longipilum*, and *Equisetum robustum*. This number would probably be reduced by extended observation. The principal distinction between the two floras is the poorer quantitative development of the bunch-grasses in the black-jack association, and a corresponding increase in the representation of the other species. In the edge of the woods, which differs the least from the prairie both in age and in ecology, the bunch-grasses are well developed, and the majority of the species may be found. In the older and more densely shaded parts the bunch-forming species are *Panicum cognatum, Tricuspis seslerioides, Eragrostis trichodes, Paspalum setaceum*, and *Andropogon furcatus*, and the bunches are few and widely scattered. This difference in development in the two formations is probably due entirely to the amount of light. The remainder of the flora is characterized by the great-

er proportion of *Callirrhoe triangulata* and *Cracca virginiana*. The latter is extremely abundant, and grows in dense circular patches ten feet or more in diameter. *Callirrhoe triangulata* is likewise abundant, and, although not forming dense patches like *Cracca*, displays its showy purple flowers in profusion, producing an effect rivaled only by the yellow beds of *Cassia chamaecrista* on the prairies. Other prominent members of the flora are *Opuntia humifusa*, *Allionia nyctaginea*, *Cassia chamaecrista*, *Froelichia campestris*, *Meibomia sessilifolia*, *Helianthus occidentalis*, and *Helianthemum majus*, all of which are found also on the prairies. There are, however, a number of species which apparently do not occur beyond the forest. Most important among these are the following:

Pteridium aquilinum	*Anychia canadensis*
Polygonum cristatum	*Erysimum arkansanum*
Talinum rugospermum	*Cassia nictitans*
Meibomia nudiflora	*Hypericum sphaerocarpum*
Meibomia paniculata	*Lechea villosa*
Ipomœa pandurata	*Pentstemon hirsutus*
Nabalus asper	*Galium pilosum*
Artemisia caudata	*Helianthus illinoensis*

The structure of the vegetation of the black-jack association is remarkably uniform, the only variations being due to differences in the light intensity. In natural clearings there is a preponderance of *Cracca virginiana*, *Helianthus occidentalis*, and *Rhus aromatica*, while a few species of the bunch-grass association, such as *Cassia chamaecrista*, *Ambrosia psilostachya*, and *Monarda punctata*, may be found with them. In the clearings *Crotonopsis linearis* is the prevailing form, associated with a number of other species.

Tables X. to XII. give counts in the black-jack association.

A tension zone, with intermediate ecological characters and a mixture of species is not developed between the black-jack association and the prairie. Its absence is an indication of the relatively slight ecological differences between the earlier stages of the black-jack and the mature prairie, but with the gradual development of the forest great changes occur. The

soil is still a pure sand, but since it is protected by the trees from the wind and from the light and heat of the sun, it does not dry out so rapidly. For the same reasons the atmospheric humidity is conserved, and the oxidization of organic matter

TABLE X. BLACK-JACK ASSOCIATION.

	Open					Brush											
Cracca virginiana	b*	d	c	a	a	o	d	g	b	d	o	b	o	f	c	f	o
Opuntia humifusa	a	b	a	a	b	a	b	c	c	o	o	o	b	b	b	a	b
Aristida tuberculosa	o	o	g	f	f	c	d	c	f	c	f	e	o	e	e	d	f
Euphorbia corollata	o	a	a	b	a	a	a	o	o	o	a	b	a	a	a	o	a
Teucrium canadense	o	a	a	b	o	d	o	b	a	o	o	c	b	o	o	a	c
Rhus aromatica	f	o	o	o	o	g	f	o	o	e	o	o	g	o	e	a	o
Crotonopsis linearis	c	f	c	d	d	o	o	o	o	o	o	o	o	o	o	o	d
Helianthemum majus	o	a	o	a	a	o	o	o	o	o	o	a	a	a	o	o	o
Monarda punctata	o	o	a	a	a	o	o	o	b	o	b	c	a	o	o	o	o
Ambrosia psilostachya	o	o	o	o	o	o	o	o	a	o	b	o	o	o	b	o	o
Helianthus occidentalis	o	o	o	c	b	o	o	o	o	o	o	o	o	o	o	o	o
Œnothera rhombipetala	o	o	o	o	o	o	o	o	a	o	o	a	o	o	o	o	o
Leptilon canadense	o	o	o	o	o	o	o	o	o	o	a	o	o	o	o	o	a
Asclepias tuberosa	o	o	o	o	o	o	a	o	o	o	o	o	o	o	o	o	o
Sporobolus cryptandrus	o	o	o	o	o	o	o	o	a	o	o	o	o	o	o	o	o
Cyperus filiculmis	o	o	o	o	o	o	o	o	o	o	o	o	o	o	a	o	o
Lespedeza capitata	o	o	o	o	o	o	o	o	o	o	o	o	a	o	o	o	o
Panicum sp.	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	a

Other species: *Chrysopsis camporum*, *Rudbeckia hirta*, *Bouteloua hirsuta*, *Euphorbia Geyeri*. The trees were not included.

lying on or near the surface of the sand is retarded. The annual leaf-fall is of course much larger, and instead of being blown about by the wind it is held by the dense growths of *Rhus* and *Cracca*, and forms a layer over the sand which increases annually in thickness. This holds a portion of the rain-water at the surface of the sand, and is eventually con-

* See p. 159.

verted into a thin layer of leaf-mold. The deeper roots of the trees penetrate to, and draw a portion of their inorganic food from, the lower strata of sand, and much of this is returned to the soil in the dead leaves, thus restoring to the upper layers of the sand some of the food matter leached out by years of rainfall.

TABLE XI. CLEARING IN BLACK-JACK ASSOCIATION.

Crotonopsis linearis	g*	g	g	g	g	b	g
Opuntia humifusa	b	b	c	c	c	c	b
Monarda punctata	b	a	b	a	a	a	d
Cracca virginiana	a	o	d	o	d	b	a
Rhus aromatica	a	c	b	o	o	g	a
Ambrosia psilostachya	o	o	o	d	c	o	c
Chrysopsis camporum	a	o	o	o	o	o	o

Other species: *Teucrium canadense*, *Euphorbia corollata*.

TABLE XII. NATURAL OPENING IN BLACK-JACK ASSOCIATION.

Helianthus occidentalis	f*	f	f	f	g	f
Cracca virginiana	e	e	f	e	f	f
Rhus aromatica	a	c	a	c	d	c
Opuntia humifusa	c	c	o	b	c	c
Ambrosia psilostachya	c	o	o	c	c	c
Onosmodium carolinianum	o	o	a	c	o	o
Helianthemum canadense	o	o	o	a	a	o
Eragrostis trichodes	o	o	a	o	a	o
Asclepias verticillata	o	o	o	o	a	a
Monarda punctata	o	o	o	a	o	o
Cassia chamaecrista	b	o	o	o	o	o

Other species: *Callirrhoe triangulata*, *Carex gravida*.

* See p. 159.

These changes go on very slowly. There are now areas of black-jack covering several square miles with scarcely a trace of leaf-mold. This is illustrated especially by the black-jack timber south of Havana between Bath and Kilbourne, where, in a belt five miles wide, there is nothing but pure sand without any covering of humus. In the country east of Havana, where the sand is mostly confined to long wooded dunes, and near the Illinois River, the formation of the soil appears to be more rapid. Some of the wooded ridges back from the river have a coating of leaf-mold only half an inch to an inch in thickness, and the cacti still growing in it show that it has been but a few years since its formation.

With the first traces of leaf-mold such semi-xerophytic plants as *Aquilegia canadensis, Triosteum aurantiacum, Silene stellata, Anemone virginiana*, and *Agrimonia mollis* begin to appear, together with many other species common to most upland-wood associations, although many of the sand-loving xerophytes, such as *Callirrhoe triangulata, Rhus aromatica*, and *Lespedeza capitata*, still persist. As the soil increases in depth more characteristic mesophytes appear, including *Vagnera racemosa, Vagnera stellata, Geum canadense, Asclepias exaltata*, and *Eupatorium ageratoides. Parthenocissus quinquefolia* becomes very abundant, climbing up most of the trees, and trailing prostrate on the sand, covering it with a dense mat. The arborescent flora is still unchanged; the two oaks and the hickory constitute nearly all of the forest, and the only additions are small scattering trees of *Cercis canadensis, Morus rubra*, and *Celtis occidentalis*.

None of the black-jack forests observed has as yet passed beyond this semi-mesophytic stage except in a narrow belt along the Illinois River (Pl. XXI., Fig. 2), where plants from the neighboring mesophytic and hydrophytic forests may spread more quickly over the sand ridges. In such places the forests of the wooded dunes contain but a small proportion of black-jack oak, its place being taken by bur-oak (*Quercus macrocarpa*) and white oak (*Quercus alba*). The leaf-mold is deep, and the

herbaceous flora resembles that of the most mesophytic of our upland woods.

SOME ADAPTATIONS OF THE PLANTS TO THE ENVIRONMENT.

The plants of the sand region are nearly all xerophytes, and as such show many xerophytic adaptations for the reduction of transpiration. Some of the more important of these are given below, and illustrative plants mentioned.

1. *Reduction of the Leaf Surface.*—*Opuntia humifusa*, the cactus or prickly pear so common throughout the region, is the best example. The leaves are no longer functional, and the green succulent stem is divided into flat obovate joints which transpire very slowly.

2. *Thick or Succulent Leaves.*—*Talinum rugospermum* has a basal cluster of cylindrical succulent leaves one to two inches long. *Physostegia virginiana* when growing on the sand prairies has blunt-toothed leaves, slightly folded along the midrib, and greatly thickened. The difference between this leathery-leaved xerophytic form and the thin-leaved mesophyte abundant along ditches and sloughs elsewhere in the state, is very striking.

3. *Narrow or Linear Leaves.*—A reduction of the transpiring surface by linear leaves occurs in many species, among which are *Polygonum tenue*, *Polygala verticillata*, *Petalostemon candidus* and *P. purpureus*, *Phlox bifida*, and *Ionactis linariifolius.*

4. *A Protective Covering of Hairs or Scales.*—This is one of the commonest adaptations for preventing excessive transpiration, and is found on a great many of the species. *Froelichia campestris* is softly gray-hairy throughout; *Amorpha canescens*, *Cracca virginiana*, and *Chrysopsis camporum* are densely hairy, giving them a gray appearance; and *Croton glandulosus* has a thin covering of stellate hairs. The linear leaves of *Crotonopsis linearis* are silvery with stellate hairs, and in *Lesquerella spathulata* there is a basal rosette of spatulate leaves silvery with stellate pubescence. The glandular hairs with which the stem of *Cristatella Jamesii* is covered, hold the sand blown against it by the wind, so that the plants become encased in a veritable

armor, which may be of some use in reducing transpiration. Many other species also have hairy leaves or stems. In fact, such a protective covering is so common that the landscape has not the ordinary green color, but is distinctly gray in general tone.

5. *Involute or Conduplicate Leaves.*—This adaptation is shown by many of the grasses.

6. *Position of the Leaves.*—In *Helianthus occidentalis* the thick, rough basal leaves stand with their blades nearly vertical. Prostrate plants, like *Mollugo verticillata* and *Euphorbia Geyeri*, may also be protected against excessive transpiration by their position.

As the surface of the sand dries out quickly after rains, the first few inches contain very little water, and the roots of the plants must penetrate through this dry upper layer into the moist sand below. Many species accordingly have straight tap-roots, which give off few lateral branches or none at all for the first six to twelve inches. Some of the plants of this habit are *Polygonum tenue*, *Cycloloma atriplicifolium* (Pl. XIX., Fig. 1), *Froelichia campestris*, *Cristatella Jamesii*, *Croton glandulosus*, *Euphorbia Geyeri*, and *Œnothera rhombipetala*. Others have thickened roots or rootstocks which serve for water storage, *Talinum rugospermum*, *Ceanothus americanus*, and *Ipomœa pandurata* being examples.

The sand-binding habit is best developed on the prairies, where the action of the wind is most vigorous. Chief among the sand-binders are the bunch-grasses (Pl. XIV., Fig. 2; XVIII., Fig. 1), which protect the sand from the wind by their dense tufts of culms and basal leaves, and at the same time bind it with their rootstocks and fibrous roots. If the bunches are far apart, so that the sand is exposed between them, they frequently become raised several inches above the general level, having held the sand beneath them while that not so protected has been blown away. Species without sand-binding adaptations are usually associated with the bunch-grasses and protected by them. This condition is also found in the bunch-

grass on the sand-hills of Nebraska (Pound and Clements, '00, p. 353).

Next in importance as sand-binders are certain species which grow in close hemispherical or flattened bunches, and hold the sand in the same manner as the bunch-grasses. *Rhus aromatica* (Pl. XIX.) grows in dense thickets, sometimes twenty feet in diameter, its long branching roots descending to a depth of six feet or more, and effectually resisting the movement of the sand. *Cracca virginica*, *Lithospermum linearifolium*, *Salix tristis*, *Chrysopsis camporum*, and especially *Amorpha canescens*, have the same habit as *Rhus*, but on account of their smaller size are less effectual as sand-binders.

Sporobolus cryptandrus, and *Commelina virginica* have stems prostrate and rooting at the nodes, and both are quite effectual sand-binders, although the latter species is not frequent, and neither reaches a large size. *Sporobolus* is quite abundant on level blow-sand, where it builds up mounds from four to eight inches high (Pl. XVIII., Fig. 2). It is one of the principal species concerned in fixing blow-sand and preparing it for the re-establishment of the bunch-grass association. *Commelina* also builds up small mounds and ridges of sand.

A third type of sand-binders is composed of mat plants, which have prostrate stems radiating from a central root. *Euphorbia Geyeri* is common on blow-sand, where it grows in circular mats from six inches to two feet in diameter. It thus effectually holds the sand beneath it, and is frequently seen on a flat mound an inch of two high, closely similar in shape to the plant itself. *Mollugo verticillata*, frequently naturalized on blow-sand and in the bunch-grass, has the same habit. *Opuntia humifusa* may be classed in the same group. It forms dense mats two to five feet in diameter, and effectually holds the sand. The center of the mats, however, are frequently buried. *Acerates viridiflora*, usually erect in a richer soil, is prostrate when growing on blow-sand, and builds up small mounds.

Intermediate between prostrate forms like the last and bunch-forming species like *Chrysopsis* are such plants as *Solidago missouriensis*, and *Callirhoe triangulata*. These have sev-

eral stems in a cluster ascending from a common center, and while of little importance in holding the sand they frequently collect considerable quantities about their bases.

No attempts have been made toward controlling the movement of the sand and rendering it available for agricultural purposes, but much could be accomplished in that direction. Hedges have been planted in some places, and thickets of plum-trees have been allowed to grow between cultivated fields and sand-hills. The Lombardy poplar (Pl. XX., Fig. 1) might be used with good results, as it thrives on the sand and spreads rapidly by its long underground roots.

List of the Plants Observed.*

Polypodiaceæ.

Pteridium aquilinum (L.) Kuhn.

Equisetaceæ.

Equisetum arvense L.

Equisetum robustum A. Br.

Gramineæ.

Andropogon scoparius Michx.
Andropogon furcatus Muhl.
Sorghastrum avenaceum (Michx.) Nash.
Paspalum setaceum Michx.
Syntherisma filiformis (L.) Nash.
Panicum cognatum Schultes.
Panicum virgatum L.
Panicum sp.†
Chætochloa viridis (L.) Scribn.
Cenchrus tribuloides L.

* Only those species of spermatophytes and pteridophytes which grow on the sand prairies or in the black-jack forest proper, without a covering of leaf-mold, have been included in this list. Some additional species have been reported by Patterson ('76) and McDonald ('00). The nomenclature followed is essentially that of Britton's Manual.

† Abundant on the bunch-grass prairies and of sparing occurrence in the black-jack; conspicuous and well marked by the dense tufts with the crowded, almost fastigiate, ascending leaves. The primary panicle fruits in July, and the spikelets have nearly all fallen off when the secondary panicles appear, in the middle of August. The specific identity of the plant is in doubt.

Aristida tuberculosa Nutt.
Stipa spartea Trin.
Sporobolus cryptandrus (Torr.) Gray.
Calamovilfa longifolia (Hook.) Hack.
Spartina cynosuroides (L.) Willd.
Bouteloua hirsuta Lag.
Atheropogon curtipendulus (Michx.) Fourn.
Tricuspis seslerioides (Michx.) Torr.
Eragrostis pectinacea (Michx.) Steud.
Eragrostis trichodes (Nutt.) Nash
Poa pratensis L.

CYPERACEÆ.

Cyperus Schweinitzii Torr.
Cyperus Bushii Britton.
Cyperus filiculmis Vahl.
Stenophyllus capillaris (L.) Britton.
Carex gravida Bailey.

COMMELINACEÆ.

Commelina virginica L.
Tradescantia virginiana L.

CONVALLARIACEÆ.

Salomonia commutata (R. & S.) Britton.

SMILACEÆ.

Smilax hispida Muhl.

SALICACEÆ

Populus deltoides Marsh.
Populus dilatata Ait.
Salix tristis Ait.

JUGLANDACEÆ.

Juglans nigra L.
Hicoria microcarpa (Nutt.) Britton.

FAGACEÆ.

Quercus velutina Lam.
Quercus marylandica Muench.

ULMACEÆ.

Celtis occidentalis L.

MORACEÆ.

Morus rubra L.

URTICACEÆ.

Urticastrum divaricatum (L.) Kuntze.

POLYGONACEÆ.

Polygonum emersum (Michx.) Britton.
Polygonum tenue Michx.
Polygonum cristatum Engelm. & Gray.

CHENOPODIACEÆ.

Chenopodium album L.
Cycloloma atriplicifolium (Spreng.) Coulter.

AMARANTHACEÆ.

Froelichia campestris Small.

NYCTAGINACEÆ.

Allionia nyctaginea Michx.

AIZOACEÆ.

Mollugo verticillata L.

PORTULACACEÆ.

Talinum rugospermum Holz.

CARYOPHYLLACEÆ.

Silene stellata (L.) Ait.
Silene antirrhina L.
Anychia canadensis (L.) B. S. P.

RANUNCULACEÆ.

Anemone cylindrica Gray.
Clematis Simsii Sweet.

MENISPERMACEÆ.

Menispermum canadense L.

LAURACEÆ.

Benzoin Benzoin (L.) Coulter.

CRUCIFERÆ.

Lesquerella spathulata Rydb.
Arabis lævigata (Muhl.) Poir.
Erysimum arkansanum Nutt.

CAPPARIDACEÆ.

Cristatella Jamesii T. & G.
Polanisia graveolens Raf.

GROSSULARIACEÆ.

Ribes missouriense Nutt.

ROSACEÆ.

Fragaria virginiana Grayana (Vilm.) Rydb.
Potentilla canadensis L.
Rosa humilis Marsh.

CÆSALPINIACEÆ.

Cassia nictitans L.
Cassia chamæcrista L.
Gleditsia triacanthos L.

PAPILIONACEÆ.

Baptisia bracteata Ell.
Amorpha canescens Pursh.
Petalostemon candidus (Willd.) Michx.
Petalostemon purpureus (Vent.) Rydb.
Cracca virginiana L.
Meibomia nudiflora (L.) Kuntze.
Meibomia sessilifolia (Torr.) Kuntze.
Meibomia paniculata (L.) Kuntze.
Meibomia canadensis (L.) Kuntze.
Lespedeza virginica (L.) Britton.
Lespedeza capitata Michx.
Falcata comosa (L.) Kuntze.
Strophostyles helvola (L.) Britton.
Strophostyles umbellata (Muhl.) Britton.

OXALIDACEÆ.

Oxalis violacea L.

RUTACEÆ.

Xanthoxylum americanum Mill.

POLYGALACEÆ.

Polygala verticillata L.

EUPHORBIACEÆ.

Croton glandulosus L.
Crotonopsis linearis Michx.
Euphorbia Geyeri Engelm. & Gray.
Euphorbia corollata L.
Euphorbia heterophylla L.

ANACARDIACEÆ.

Rhus aromatica Ait.
Rhus radicans L.

CELASTRACEÆ.

Celastrus scandens L.

ACERACEÆ.

Acer Negundo L.

RHAMNACEÆ.

Ceanothus americanus L.

VITACEÆ.

Vitis vulpina L.

MALVACEÆ.

Callirrhoe triangulata (Leavenw.) Gray.

HYPERICACEÆ.

Hypericum sphærocarpum Michx.

CISTACEÆ.

Helianthemum majus (L.) B. S. P.
Lechea villosa Ell.

CACTACEÆ.

Opuntia humifusa Raf.

LYTHRACEÆ.

Parsonsia petiolata (L.) Rusby.

ONAGRACEÆ.

Onagra biennis (L.) Scop.
Œnothera laciniata Hill.
Œnothera rhombipetala Nutt.
Gaura biennis L.

Umbelliferæ.

Sanicula canadensis L.
Thaspium trifoliatum aureum (Nutt.) Britton.
Polytænia Nuttallii DC.

Apocynaceæ.

Apocynum cannabinum L.

Asclepiadaceæ.

Asclepias tuberosa L.
Asclepias Sullivantii Engelm.
Asclepias amplexicaulis J. E. Smith.
Asclepias syriaca L.
Asclepias verticillata L.
Acerates viridiflora (Raf.) Eaton.

Convolvulaceæ.

Ipomœa pandurata (L.) Meyer.

Polemoniaceæ.

Phlox bifida Beck.

Boraginaceæ.

Lappula virginiana (L.) Greene.
Lithospermum Gmelini (Michx.) A. S. Hitchcock.
Lithospermum linearifolium Goldie.
Onosmodium carolinianum (Lam.) DC.

Verbenaceæ.

Verbena stricta Vent.
Verbena bracteosa Michx.

Labiatæ.

Teucrium canadense L.
Prunella vulgaris L.
Physostegia virginiana (L.) Benth.
Monarda punctata L.
Blephilia ciliata (L.) Raf.
Hedeoma pulegioides (L.) Pers.
Koellia flexuosa (Walt.) MacM.
Koellia pilosa (Nutt.) Britton.

Solanaceæ.

Physalis virginiana Mill.

Physalis heterophylla Nees.
Solanum nigrum L.
Solanum carolinense L.

SCROPHULARIACEÆ.

Verbascum Thapsus L.
Scrophularia marylandica L.
Pentstemon hirsutus (L.) Willd.
Pedicularis canadensis L.

ACANTHACEÆ.

Ruellia ciliosa Pursh.

PHRYMACEÆ.

Phryma leptostachya L.

RUBIACEÆ.

Diodia teres Walt.
Galium pilosum Ait.
Galium circæzans Michx.

CUCURBITACEÆ.

Sicyos angulatus L.

CAMPANULACEÆ.

Campanula americana L.
Specularia perfoliata (L.) A. DC.
Lobelia spicata Lam.
Lobelia leptostachys A. DC.
Lobelia inflata L.

CICHORIACEÆ.

Lactuca canadensis L.
Hieracium longipilum Torr.
Nabalus asper (Michx.) T. & G.

AMBROSIACEÆ.

Ambrosia artemisiæfolia L.
Ambrosia psilostachya DC.

COMPOSITÆ.

Eupatorium purpureum L.
Eupatorium serotinum Michx.
Kuhnia eupatorioides L.

Kuhnia glutinosa Ell.
Lacinaria scariosa (L.) Hill.
Chrysopsis camporum Greene.
Solidago ulmifolia Muhl.
Solidago missouriensis Nutt.
Solidago nemoralis Ait.
Solidago rigida L.
Euthamia caroliniana (L.) Greene.
Aster ericoides L.
Leptilon canadense (L.) Britton.
Ionactis linariifolius (L.) Greene.
Antennaria sp.
Anaphalis margaritacea (L.) Benth. & Hook.
Gnaphalium obtusifolium L.
Heliopsis scabra Dunal.
Rudbeckia triloba L.
Rudbeckia hirta L.
Ratibida pinnata (Vent.) Barnh.
Helianthus scaberrimus Ell.
Helianthus occidentalis Riddell.
Helianthus illinoensis Gleason*.

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*Helianthus illinoensis.—Erect, six to ten dm. high, from a long running rootstock. Stem simple, slightly angled, densely villous below, pubescent above. Leaves six to eight pairs, strictly opposite, slightly scabrous above, softly pubescent beneath and villous on the veins, obtuse; the lowest four or five pairs oblong-lanceolate to ovate-lanceolate, three-nerved, entire, ten to fifteen cm. long, tapering at the base into a villous winged petiole equaling or but little shorter than the leaves; the upper two or three pairs much smaller or bractlike, petiole, short or none. Lower internodes five to eight cm. in length, or the two lowest pairs of leaves approximate, upper internodes much longer. Inflorescence of one to seven heads; peduncles three to ten cm. long; involucre broadly campanulate or hemispherical, eight mm. high; scales lanceolate, acuminate, ciliate. Disk flowers yellow, rays about thirteen, two to three cm. long, bright yellow, achenes minutely pubescent. Flowers in August.

On the sand dunes along the Illinois river near Havana, where it is common in the black-jack oak woods, especially along the edges and in the more open and sunny places. Material was collected in 1903 and 1904, and the type, collected on August 17, 1904, is in the herbarium of the Missouri Botanical Garden.

Helianthus illinoensis is evidently closely related to *Helianthus occidentalis* Riddell, which it resembles in the reduction in size of the upper leaves. It is at once distinguished from the latter species by the villous pubescence and the greater length of the lower internodes. The two are sometimes associated in the field, but in general appearance they are entirely distinct. *Helianthus occidentalis* has broad, scabrous,

Helianthus strumosus L.
Coreopsis palmata Nutt.
Achillea Millefolium L.
Artemisia caudata Michx.
Mesadenia atriplicifolia (L.) Raf.

PHYTOGEOGRAPHICAL RELATIONSHIPS OF THE FLORA.

A casual inspection of the preceding list of species, 188 in number, will show the presence in the sand vegetation of numerous plants of western distribution. Some of these occur in Illinois only in the sand regions, so far as known, and others are of limited range in various parts of the state. In order to study more carefully this western relationship the flora has been divided into two groups, including, first, those species living in the prairie formation, and, second, those found only in the black-jack forest. It is believed that this separation will distinguish the older and more primitive flora, inhabiting the older plant-formation, from the younger and more recent flora, occupying the younger formation, and doubtless derived to a large extent from the vegetation of the surrounding woodlands and prairies. It has been mentioned that nearly all the species of the sand prairie grow also in the black-jack, and that their presence there is probably due frequently to persistence through the changed ecological conditions. It is also evident that many of the more recent species have penetrated into the bunch-grass prairies and are now mingled with the endemic element there. A third and minor group of five species has not been included in this division, since its members occur only on the front of dunes which have invaded natural groves on the Miami loam, and are undoubtedly derived directly from the vegetation of that soil. These are *Clematis Simsii*, *Euphorbia heterophylla*, *Sicyos angulatus*, *Solanum nigrum*, and *Urticastrum divaricatum*.

The vegetation of Illinois, with the possible exception of the extreme southern part, has been developed since the close of the glacial period. Postglacial migration into the state has

light green, short-petioled leaves which are nearly erect in a basal cluster, while in *Helianthus illinoensis* they are darker green, more or less spreading and scattered on the stem.—OHIO NATURALIST, Vol. V. (1904), p. 214.

proceeded from three principal centers or zones: the Austroriparian zone or Coastal plain, a U-shaped area lying along the Atlantic and Gulf coasts and the lower Mississippi valley: a southeastern center lying within the U, and a southwestern one lying to the west of it. The last two centers have furnished most of the plants of the sand region and, indeed, of Illinois as a whole, and the floral elements from them will be spoken of as the Atlantic and the Sonoran elements respectively. A northern extension of the Sonoran element has occupied the inland territory designated by Engler as the Prairie province, and an eastern arm of this province reaches across northern Illinois into Indiana. This is shown by Pound and Clements on their map of the Prairie province ('98, '00). This arm is almost surrounded on the north, east, and south by the Atlantic province, and it is also intersected along the streams by broad or narrow strips of woodland, representing the same province. When we consider also the fact that in Illinois the forests are climatic and the prairies edaphic, it is not surprising that the Sonoran floral element in the Illinois prairies is obscured by the presence of a large number of species of the Atlantic element derived from the adjacent forests.

Of the 117 species growing on the prairie formation of the sand region 34, or 29 percent, are of typically western range, that is, from Illinois west across Nebraska and thence south into Texas, a distribution in many cases practically coincident with the Prairie province and clearly indicative of their Sonoran origin. These are as follows:

**Equisetum robustum*	*Petalostemon purpureus*
Stipa spartea	**Euphorbia Geyeri*
**Calamovilfa longifolia*	**Callirrhoe triangulata*
**Bouteloua hirsuta*	**Opuntia humifusa*
**Eragrostis trichodes*	**Œnothera rhombipetala*
**Cyperus Schweinitzii*	*Asclepias Sullivantii*
**Cyperus Bushii*	*Lithospermum Gmelini*
Carex gravida	*Lithospermum linearifolium*
**Cycloloma atriplicifolium*	*Verbena stricta*
**Froelichia campestris*	*Verbena bracteosa*

**Allionia nyctaginea*	**Ambrosia psilostachya*
Anemone cylindrica	*Hieracium longipilum*
**Lesquerella spathulata*	**Kuhnia glutinosa*
**Cristatella Jamesii*	**Chrysopsis camporum*
**Polanisia graveolens*	*Solidago missouriensis*
Baptisia bracteata	*Helianthus scaberrimus*
Amorpha canescens	*Coreopsis palmata*

This group in the prairie formation is obscured by the presence of 65 species, or 56 percent, of eastern distribution, to be regarded as derivatives of the Atlantic floral element; and the remaining 18 species, or 15 percent, include 9 of transcontinental distribution, 4 introduced species, 2 (**Aristida tuberculosa* and **Sporobolus cryptandrus*) with a range along the coast of the Atlantic and Great Lakes and locally in the interior, and 3 whose range is local or unknown, namely, **Panicum* sp., *Phlox bifida*, and *Antennaria* sp.

The importance of the Sonoran element can be shown to better advantage by excluding all those species which occur commonly in other associations in the state, limiting the list to the plants most characteristic of the sand region. Of the 28 species thus selected, 1 is local, 2 range along the coast and the Great Lakes, 6 are eastern or southeastern, and 19, or 68 percent, are western or southwestern. In the preceding list and in the paragraph following it, 22 of these species are marked with an asterisk. The 6 eastern species included are

Panicum cognatum	*Polygonum tenue*
Cyperus filiculmis	*Monarda punctata*
Salix tristis	*Ionactis linariifolius*

The 66 species of the sand region which are found only in the black-jack association include 1 of local distribution, *Helianthus illinoensis*; 1 introduced species, *Chætochloa viridis*; 9 of western distribution; and 55 of eastern and southeastern range, indicating plainly the eastern relationships of the flora, and the floral similarity of the black-jack to the other forests of central Illinois. Of these 55, all but one, *Polygonum cristatum*, occur also in other plant associations within the state, while of

the 9 western species, three, starred in the following list, are practically confined to the sand region.

Atherpogon curtipendulus	*Polytænia Nuttallii*
**Talinum rugospermum*	*Nabalus asper*
**Erysimum arkansanum*	*Ratibida pinnata*
Ribes missouriense	**Artemisia caudata*
Petalostemon candidus	

A comparison of the vegetation of the Illinois River valley sand region with that of the dunes along Lake Michigan is of interest on account of the short distance between the two regions. Excepting the temperature, the difference in the ecological conditions is scarcely sufficient to cause a wide variation in the floras. The dunes of Lake Michigan, however, are essentially a beach formation, and the vegetation as described by Cowles ('99) shows but slight relationships with the western prairies. On the beach proper only eight species occur which are common to the two dune areas, and three of these, *Artemisia caudata, Calamovilfa longifolia,* and *Lithospermum Gmelini,* are western in their range. The flora of the shifting dunes shows scarcely more similarity. In the established dunes the resemblances are stronger. Six species of the basswood dunes and nearly all those of the oak dunes are found also in the inland region, and Cowles's list includes *Quercus velutina, Rhus aromatica, Cracca virginiana, Cyperus Schweinitzii, Opuntia humifusa, Œnothera rhombipetala, Monarda punctata,* and other species abundant on the sand along the Illinois River. In both localities these plants belong principally to the derived element; and as the adjacent forests are of the same type in both regions it is to be expected that the same species would be able to adapt themselves to the sand. It is in the endemic element that the greatest contrast lies. The dunes of Lake Michigan have no *Cristatella, Eragrostis trichodes, Bouteloua, Ambrosia psilostachya, Froelichia, Euphorbia Geyeri, Callirrhoe,* or *Chrysopsis,* all characteristic of the inland region; while the latter lacks *Cakile americana, Corispermum hyssopifolium, Euphorbia polygonifolia, Lathyrus maritimus, Ammophila arenaria,* and

Prunus pumila, representing the endemic element along the lake.

A comparison with the flora of the sand-hills of Nebraska, on the other hand, shows some striking similarities. Rydberg ('95) lists 35 species as characteristic of the sand-hill region, and of these, 15, or nearly one half, grow also in the central-Illinois sand region, and this includes a number of the most abundant species. Of the 188 species enumerated in this paper, 75, or 40 percent, are included also in Rydberg's list.

It is evident from the preceding paragraphs that as a whole the flora is essentially western in its relationships. Its position within the Prairie province, as defined by Pound and Clements, can not be questioned, and the region may well be regarded as an isolated portion of the sand-hill division of the Prairie province, formed under peculiar conditions, but closely resembling the main body in its ecology and vegetation. The species found only in the black-jack oak forest are almost entirely eastern in their distribution, and have usually a wide range through the state in different plant associations.

Of especial interest from a phytogeographical standpoint are *Cristatella Jamesii* and *Lesquerella spathulata*. This is the first report of their occurrence in Illinois, and, so far as known, at any station east of central Nebraska. The former ranges through the sand-hill region from Nebraska south into Texas, and according to Britton's Manual into Louisiana. In Nebraska it lives in almost precisely the same conditions as in this state; that is, in the bottoms of blowouts, where there is a comparatively rapid shifting of the sand In 1903 it was found in but a single blowout near Havana, and the total number of individuals was probably less than five hundred. In 1904 it had spread to two other blowouts in the same field, and it was also found in great profusion in a large blowout about ten miles northeast of Havana. *Lesquerella spathulata*, described in 1896 from the Black Hills, ranges, according to Britton, from Nebraska to Montana and the Northwest Territory. Rydberg's original plants ('96) grew on dry hilltops, a habitat paralleled by its growth in Illinois in the bunch-grass

association on some of the highest dunes of the region. It is not mentioned by Pound and Clements in the "Phytogeography of Nebraska." It was collected in Illinois in but one station, northeast of Havana, near the second station for *Cristatella*.

Part III. Zoological Studies in the Sand Regions of the Illinois and Mississippi River Valleys. By Charles A. Hart.

General Features.

As a preliminary to the zoological discussion, the general topography of the principal sand areas, given in Part I. of these studies, may be briefly summarized. These areas occur on the glacial flood-plain of the broad central basin of the lower Illinois valley between Peoria and Meredosia, and of the upper Mississippi from near Burlington, Iowa, to Savanna, Ill., aggregating approximately 280 square miles in the Illinois valley alone; and considerable tracts of loose wind-blown surface sand, or "blow-sand" (Pl. X.–XV., XIX.), occur in both these areas, which in the Illinois basin are scattered in broad undulating tracts of dune formations, or in ridges running lengthwise of the valley, and reaching a maximum height of about one hundred feet.

In Part II. Mr. Gleason has quite fully discussed the present condition of the surface of these areas in the Illinois valley and the effects of wind action in their intimate relation to the plant covering, and a knowledge of these conditions is necessary to an understanding of the sand fauna, which, of course, consists largely of insects and their near relatives.

The areas of nearly pure sand are the only ones having a distinctly different flora and fauna from that of the ordinary Illinois prairie. They are most extensively developed upon the western half of the glacial flood-plain—the half next the present river bottom. Here there is little or no surface drainage, the rainfall being quickly absorbed. After a rain the sand soon dries perfectly at the surface, both in winter and summer, thus approximating the conditions of an arid region notwithstanding the greater precipitation. The striking affinities of its fauna and flora with those of the arid West are evidence of this. Nevertheless, as is more or less the case even in arid lands, the

deeper sands are always moist,—in the Illinois valley only a few inches below the dry surface layer.

Much of the blow-sand is a remnant of the greater areas which existed before vegetation invaded these sands. There is little doubt, however, that attempts on the part of man to cultivate or pasture the vegetation-covered sand land have in many cases resulted disastrously and renewed the drifting action, the destruction of the plant-cover giving the wind a chance to cut in and set the sand in motion again, starting, as it were, an open sore on the face of nature. For this reason large tracts of such land have never been disturbed, and still retain their original flora and fauna; and other fields, after attempts at cultivation, have been allowed to go to waste. The processes for the redemption of sandy land now being devised by the United States government should be utilized here, at least to keep this sand where it is and prevent its invasion of cultivable ground. These wind excavations are called blowouts (Pl. VIII., IX.), and if large enough they soon become the windward side of an advancing dune (Pl. XI.). Usually they are rounded pits, sometimes large enough to contain a house, the shifting slopes barren of vegetation, and the marginal vegetation being undermined and swept away. When their depth becomes excessive, moisture at the bottom checks the wind action at this point, and a flora and fauna approximating the ordinary prairie type takes possession of this part of the blowout. The sand from blowouts may pile up in a barren dune or ridge, over the crest of which it drifts in a fine mist with every wind, thus steadily advancing and burying the smaller trees and bushes in its path (Pl. X.; XII., Fig. 2); or it may scatter out over comparatively level areas (Pl. XIII.). Clumps of trees or small groves, by checking the wind and thus favoring the deposition of sand, occasion the formation of an active dune surrounding them on their windward side, which at least partially submerges them in the course of time (Pl. XX., Fig. 2).

At the earliest opportunity, however, a growth of vegetation, scanty at first, tries to take possession of all blow-sand areas, thus tending to stay the drifting and to fix the surface

as it is. (Pl. XIII.; XIV., Fig. 1; XV.) Frequently a later stage of this evolution is the growth of large tracts of a scrubby black-jack forest (Pl. VIII.; XXI., Fig. 1.), and this, in turn, by the gradual formation of leaf-mold, approaches the character of the ordinary Illinois forest. Forests of the latter class (Pl. XXI., Fig. 2) are especially noticeable on the fixed dune ridges which lie along the edge of the sand plain, next the river or its bottom-lands, such as the ridge extending through the city of Havana. The areas of blow-sand and black-jack are about equal, that of the final stage comparatively small.

A very different and characteristic sand fauna and flora may be found upon the constantly moist strip of sand which usually occurs along the present stream valleys at the margin of the sand plain, twenty to forty feet below its surface level, not only upon the present shores (Pl. XXIII.), but also along the line where the absorbed rainfall of the sand plain drains out upon the river bottoms at the foot of the present low marginal bluff.

The Localities Visited.

The most remarkable sand area known to me in Illinois is in the out-of-the-way interior of the low sand plateau indicated by Leverett ('99, Pl. VI.) as an island in the channel of the Chicago outlet north of Havana (see map; also p. 143 of this article). The eastern margin of this ancient island is skirted by the Chicago, Peoria and St. Louis Railway, but from the train only a suggestion of its character appears. It is approximately five or six miles wide and twenty miles long, having an area of about one hundred square miles. The middle third is especially sandy and almost entirely waste land. About half of this is covered with black-jack, and the other half, especially the south-central part, contains blow-sand to an extent not surpassed anywhere else in the state, this region being locally known as the Devil's Neck (Pl. XII., Fig. 1; XIV., Fig. 1; XX., Fig. 1). One tract of about eighty acres is almost entirely blow-sand in successive ridges, suggesting great ocean waves in a storm. Blowouts of unusual extent surround it on all sides, and

vegetation is scanty or altogether absent. The fauna and flora here are so distinctly western that this tract might almost be considered as a detached islet of the Upper Sonoran life zone.

The other localities most frequently visited, were (1) the Devil's Hole (Pl. XIII.; XIX., Fig. 1; XX., Fig. 2), a similar but much smaller tract of blow-sand a mile or so east of Havana; (2) the exceptionally broad area of very sandy land south of Havana (Pl. VIII.–XI., XV.–XVII.), with numerous small tracts of blow-sand and large bodies of black-jack timber; (3) the less sandy and better-forested submarginal ridges, often fifty feet or more in height, which extend through Havana, especially those a mile or two north of the city, in the vicinity of Quiver Lake (Pl. XXI., Fig. 2); and (4) the moist sand strip at the base of the low marginal bluff of the sand plain (Pl. XXIII.), saturated more or less extensively with outflowing ground-water, in part forming the east shore of the river and of bottom-land lakes bordering on the sand plain.

Two additional localities, both at a considerable distance from Havana, were visited in 1905. One of these was Meredosia, near the southern end of the central basin, about forty-five miles below Havana. A small tract of blow-sand, with a few blowouts and some black-jack, lies immediately south of the town, and the distinctive sand fauna observed about Havana seemed well represented here also. Aside from this, there seemed to be very little blow-sand in the vicinity. The other locality was the Moline Sand Hill, described by McNeill ('91, p. 73). This extends along the Rock River, near its mouth, only a few miles from the city of Moline, on the Mississippi, just across the narrow intervening divide. It is a conspicuous elongate sand-hill, about a quarter of a mile long, near the south bank of the river. At the east end of the crest is an acre or two of undisturbed waste land, with a group of several good-sized blowouts, bordered by a small fringe of willow and Carolina poplar on the east slope of the hill. The sand is here apparently finer than at Havana. The fauna differs slightly from that of the Illinois valley regions, but not to any marked degree. While there are other and larger blow-sand areas in this

part of the Mississippi valley, none of them are in this immediate vicinity, and it seems remarkable that the distinctive sand fauna should be so well represented in so restricted an area.

Geographical Distribution of the Species.

Professor A. P. Morse has truthfully said of the *Acridiidæ* ('99, p. 332): "Locust distribution is primarily and very distinctly climatal in character. * * * In its details it is influenced to a very high degree by physiography and its attendant conditions, such as character of the soil, humidity, etc. In its broader features it is eminently characteristic of life zones and regions. * * * It is in many cases dependent on and confirmatory of geological changes. For these reasons and those noted at the beginning, viz., wide distribution, terrestrial and conspicuous habits, numerical abundance, size, etc., the family and its distribution are of high importance in a study of life zones in their relation to agriculture, and of faunal regions in their relation to general science."

The *Acridiidæ* of the sand region received my especial attention, and, fortunately, the work of Blatchley ('03), Bruner ('97), and Gillette ('04) has furnished very satisfactory lists for a comparison of species with those of neighboring states in the same faunal zone.

There are now known from the United States and Canada, in round numbers, about 650 *Acridiidæ*. Blatchley has listed 64 in Indiana. McNeill's Illinois list ('91) was somewhat incomplete, and contained only 55 species. Our present Illinois list numbers about 78 species, to which may properly be added for this discussion four species found by Blatchley near the Illinois line, but which we have not yet searched for in the same kind of situations near by on our side of the line. This makes a practical total of 82 species for Illinois. Conversely, we have found in eastern Illinois, although not near the boundary line, two species which probably occur in Indiana, though not listed by Blatchley. Bruner has recorded 150 species in Nebraska, and Gillette 133 for Colorado. Groups of species variously recognized by different authors have been equalized in these counts.

We have, then, as the nearest approximation to the truth attainable at the present time:

Indiana, 66 species,	Nebraska, 150 species,
Illinois, 82 species,	Colorado, 133 species.

The excess in Illinois as compared with Indiana is very largely due to its western sand districts: while the great variety in Nebraska may properly be ascribed to its wide range of soil and climate, from the humid Missouri valley to the arid sand hills of its western part. The suitability of an arid environment for acridiid development is also evident in these figures. A comparison of the species of the three states first mentioned shows that with the exclusion of the *Tettiginæ*, which cannot be accurately compared at present, Nebraska contains nearly all the species of Indiana and Illinois, and Illinois probably nearly all of those of Indiana. Ten species of Illinois or Indiana do not occur in Nebraska lists. These include two quite rare Illinois species, *Mecostethus platypterus* and *Melanoplus walshi*; five northern species, *Trimerotropis maritima*, *Paroxya scudderi*, and *P. hoosieri*, *Melanoplus extremus*, and *M. islandicus*, the last three of which have not yet been taken in Illinois; and three southern species, *Trimerotropis saxatilis*, *Eritettix virgatus*, and *Melanoplus impudicus*, the first two not yet taken in Indiana.

The *Acridiidæ* of Champaign county in the vicinity of the University of Illinois have received a great deal of attention, and 32 species have been taken. This is a typical series of the ordinary prairie and forest, not only of east-central Illinois, but also of Indiana, of western Illinois, and of at least the adjacent parts of Missouri and Iowa. These species should certainly be found in the Illinois River valley, as there is no lack of suitable situations for all; they have merely not yet been searched for, except in the sand region. There, 19 of them are known to occur, and the same region, moreover, has 26 species not yet found in Champaign county and not likely to be found there, making an actual total of 45 (about one half more than in Champaign county), and a probable total for the central lower valley of 58—nearly twice that of Champaign county.

Selecting the more distinctive sand *Orthoptera* of the Illinois valley district, only three of which (*Syrbula admirabilis, Spharagemon bolli* and *Melanoplus atlanis*) have been found in Champaign county in dry situations, and comparing them with those of other sand regions, the results are especially significant. The principal sand areas examined by Blatchley were two: the area of northeastern Indiana near the lower end of Lake Michigan, and that of the Wisconsin morainic outwash in Vigo county, southern Indiana, near Terre Haute. Opportunity is thus afforded for a triangular comparison, the Illinois locality being about midway between the two in latitude. There are 36 species in the comparison, 32 of which are in the Illinois district, 17 in the lake region, and 12 in Vigo county. Only four of the list are common to all three localities, but that is apparently because the Vigo county area is not so sandy as the others, these four being species of dry, but not necessarily sandy, ground. They are

Spharagemon bolli	*Melanoplus atlanis*
Schistocerca alutacea	*Melanoplus luridus*

Five more Vigo county species occur also on the Illinois valley sand, but are not recorded from the Indiana lake region. These are

Tettix arenosus	*Melanoplus impudicus*
Syrbula admirabilis	*Melanoplus minor*
Ageneotettix scudderi	

The presence of *A. scudderi* and *M. minor* in this series is a little strange; the others increase in numbers southward and hence were not found in the more northern situation.

One species (*Nomotettix compressus*) common to the two Indiana localities, although it occurs also in Illinois, has not yet been taken in the Illinois valley sand region.

Of the species common to the Illinois valley and the Indiana lake region there are 11 not found in Vigo county, most of them decided sand lovers. The four marked with a star are at or near the eastern limit of their range; the others reach the Atlantic coast states. The list is as follows:

Orphulella pelidna	*Psinidia fenestralis*
Orphulella speciosa	*Hesperotettix pratensis*
**Hippiscus tuberculatus*	*Melanoplus fasciatus*
**Hippiscus haldemanii*	**Melanoplus angustipennis*
Sphuragemon wyoming-ianum	**Phætaliotes nebrascensis*
	Conocephalus robustus

Of the species known from only one of the three localities, there are in Vigo county two, *Ceuthophilus latens* and *uhleri*, inhabiting dry sandy ground; in the lake region there is just one species, *Gryllus arenosus*, which seems peculiar to that region; and in the Illinois locality twelve have been found, the range of several of these species being extended to a very unexpected degree by their discovery here. Their previously known range is given in the appended list, which shows clearly the alliance of this sand fauna with that of the Great Plains.

Mermiria neomexicana. Wyoming to N. M., Neb. to Tex. "Rocky Mts. to Miss. R."

Mermiria bivittata. Fla., N. J., Kan., Utah, N. M., Tex., and intervening states. Lower Austral (Morse), Ill.? (McNeill).

Eritettix virgatus. Tex., Ark.

Amphitornus bicolor. "Mont. to Kan." A characteristic species of the Great Plains (Bruner).

Hippiscus phœnicopterus. "Southern U.S. east of Great Plains." Moline, Ill.

Trachyrhachis thomasi. "Upper Miss. Valley and Colorado." S. Ill. (Thom.). Ky., Ind. Classed by Blatchley as Austroriparian. Its records are confused with those of other species, but it probably occurs also from Minn. to Neb.

Campylacantha olivacea. Neb. to Tex. S. W. Ark.

Campylacantha acutipennis. Tex., Kan.

Hesperotettix speciosus. "Rocky Mts. to Miss. R." Neb. to Tex. N. M.

Melanoplus flavidus. Ariz., N. M., Tex., Kan., Col., S. W. Neb., Mont. N. W. Ill. (McNeill).

Udeopsylla robusta. "W. of Miss. R." Iowa (Osborn).

Gryllus personatus. Ariz., N. M., Tex., Col., Kan., Neb.

It now remains to compare the Illinois sand regions with the sand-hills of western Nebraska. Unfortunately, I have not a definite list for the latter locality. The general Nebraska list shows that all the *Acridiidæ* of the Illinois valley sand district are found in that state with the exception of the southern *Melanoplus impudicus* and *Eritettix virgatus*, and about half of them in the western part, but that a number of additional sand species appear in that part of the state. As to the intervening states, Missouri and Iowa, we have only an old list of about 41 *Acridiidæ* for Iowa (Osborn '92), in which 19 of the 30 Illinois-Nebraska sand species are lacking. Further knowledge of the *Orthoptera* of these states is very desirable. The occurrence of *Melanoplus impudicus* and *Eritettix virgatus* in our district gives force to Morse's suggestion ('99, p. 316) that a southern species of sandy or light-soil situations may have a more elastic northern limit than one of damp and heavy soil.

So far, therefore, as the *Orthoptera* are concerned, the evidence indicates that the fauna of the Illinois valley sand region has much stronger western affinities than that of the south end of Lake Michigan; that it is quite closely allied with that of the eastern part of Nebraska, which is within the Carolinian life zone, but can hardly be called Sonoran; and that it is of western derivation, and migrated eastward, probably by way of the glacial outwash in Iowa, at an early period.

Our entire list of western Illinois sand insects numbers 596 species. From these has been selected the following list of 85 species which seem to be not generally distributed east of the Rocky Mountains. These, of course, are the significant ones in a study of distribution. They fall into six classes with regard to the extent and direction of their range outside of western Illinois, the scattering, the local, the northern, the southern, the eastern, and the western species, and are correspondingly listed in this connection as being of especial interest, a summary statement of their previously known distribution being appended to each species. The last two groups are divided into near and distant species, the distinction being based on their presence or absence, so far as known, in states adjoining Illinois.

Each locality record from the collections of the Illinois State Laboratory of Natural History is separately indicated by the letter I. and from the Bolter Collection of Insects by B.

SCATTERING SPECIES (4).

Zuphium longicolle. Cal., Tex., Ohio (B).

Adalia bipunctata. Can. and N. S., south to N. J., west to Neb.; Col. to Ariz. Until the last few years practically unknown in Illinois; now frequent.

Lucanus placidus. Pa., Ill., Ark. (I), Minn. (B).

Lema cornuta. S. C., Kan., N. W. Ind.

LOCAL SPECIES (8).

Bacunculus blatchleyi. Ind., Wis. (B). [Throughout Ill.]

Melanoplus macneilli, n. sp. [Rock Island Co.]

Nabis elongatus, n. sp. [Mason Co.]

Harpalini, sp. [Rock Island Co.]

Harpalus testaceus. Ia., Ill.

Meroptera cviatella. Cook Co.

Sphærophthalma chlamydata. Mason Co.

Ammophila argentata, n. sp. [Mason Co.]

NORTHERN SPECIES (2).

Melanoplus fasciatus. Can., north half U. S., south limit N. J., Pa., Ind., Mo. to Col.

Melanoplus minor. Can., north half of U. S., Okl. and Ariz.

SOUTHERN SPECIES (11).

Ischnoptera inæqualis. Ga., Ind. and Tex., to C. Am.

Mermiria bivittata. Fla. to N. J., thence to Utah and N. M., Kan. to Tex., Ill.?

Hippiscus phœnicopterus. S. U. S. east of Great Plains, S. Ill., S. Ind. to N. J.

Melanoplus impudicus. N. J., S. C., and Ga., to S. Ind. and Ark.

Cicada marginata. N. J. to Utah, S. Ill., and southward.

Tettigia hieroglyphica. N. J. to Mex. Tex. (B).

Carabus sylvosus. Mass. (I)., N. Y. to Tex., Kan. (I)., Ill.

Saprinus ferrugineus. Tex., Fla. (B).

Chalcodermus collaris. N. J., D. C., Va. (B), Ky. (B), Fla. (B), Tex.

Xanthoptera semiflava. S. States, N. J. to Tex.

Bembidula capnoptera. Ga., Ky., Tex.

EASTERN SPECIES (13).

Near (9).

Sphæridium scarabæoides. Atl. Coast to Chicago. [Rock Island Co.] Introduced.

Clerus thoracicus. Pa. (I), D. C., N. J., N. Y. (B), Ill.

Opatrinus notus. Pa., D. C., N. J., Ill., Ind.

Chalepus smithi (*Odontota horni*). Mass., N. J., D. C., N.E. Ill., N.W. Ind.

Scotobates calcaratus. Vt., N. J., D. C., Mich. (B), La. (B), Ill.

Xylopinus saperdioides. Miss. R. east to Fla. (B) and Vt. (I); Wis. (B).

Proctacanthus brevipennis. N. J. to Fla., Ky.

Sphærophthalma harmonia. Mass. to Fla., Ind.

Epeolus pusillus. N. H., Mass., N. J., Ill.

Distant (4).

Mecostethus platypterus. N. Eng.

Pentatoma juniperina. E. States north of N. J., thence into Can.; Col.; Duluth, Minn. (I).

Haltica fuscoænea. Mass., Ga.

Psilocephala pictipennis. N. J., Ga., Fla.

WESTERN SPECIES (47).

Near (16).

Mermiria neomexicana. "Rocky Mts. to Miss. R.", Neb. to Tex., Wyo. to N. M.

Hippiscus haldemanii. N. W. Ind. to the Rocky Mts., N. M.

Hesperotettix pratensis. Fla., N. W. Ind., S. Ill., Ark. to Ia. and west to Cal.

Hesperotettix speciosus. Miss. R. to Rocky Mts., Neb. to Tex., N. M., S. Ill. prairie (I).

Melanoplus flavidus. N. W. Ill.; S. W. Neb., Kan., Tex. and Ariz. to Mont.

Melanoplus angustipennis. S. E. Ind., Ia. to Kan. and Mont., Tex.

Phœtaliotes nebrascensis. N. W. Ind., N. W. Ill., Ia., Tex. to Alberta.

Udeopsylla robusta. "W. of Miss. R.", Ia., N. M.

Cicada dorsata. Ill. to Tex., Ia., Kan., Col.

Nothopus zabroides. "Western States", C. Ill., Ia., L. Sup. (B), Neb. (B), Col. to Ariz. and N. M.

Lacon rectangularis. Ind. and Ill. to Col.; Kan., Tex. (B), S. States.

Chrysomela auripennis. N. W. Ind., Fla. (B), Neb. to Tex., Col.

Heliocheilus paradoxus. "Mid. Miss. Valley, south and west." Col., Tex.

Olethreutes dimidiana. Mo. (Identification doubtful.)

Anthrax halcyon. Ind. to N. D., and Ariz.

Tetralonia dilecta. Ill. (Robertson), Kan., Col., Tex., N. M.

Distant (31).

Eritettix virgatus. Ark., Tex.

Amphitornus bicolor. Mont. to Kan.

Campylacantha olivacea. S. W. Ark., Neb. to Tex., S. Ill. prairie (I).

Gryllus personatus. Neb., Kan., Col., Tex. to Ariz.

Sinea confusa. Tex., Ariz., Cal.

Zelus socius. Dak., Kan., Tex., Ariz., Col., Id., Cal.

Zelus renardi. "W. St.", Cal.

(The next four species have each a single eastern record, probably in areas similar to the Illinois sand region.)

Stachyocnemis apicalis. Dak., Tex., Mex., Cal. Fla.

Catorhintha mendica. I. T. and Col. to C. Am., Dak., Cal. Fla.

Cydnus obliquus. Col., Utah, Tex. to Cal., Mex. N. Y.

Corimelæna ciliata. Kan., Col., Oreg., Cal. Fla.

Brachynemurus irregularis. Tex. Havana (Currie).

Myrmeleon immaculatus occidentalis. La., Col., Nev., Ariz., N. M. Havana (Currie).

Polyphylla hammondi. Tex. to Ariz.

Mecas pergrata. Dak to Tex., Col., Kan., and N. M. (B), S. Ill. prairie (I).

Metachroma angustulum. Mont.

Metachroma parallelum. Mont., Kan.

Epitragus acutus. Kan., Tex., Mex.

Phacepholis candida. Kan., Col., Tex. and N. M. (B).

Acontia lactipennis. Tex.

Crambus haytiellus. Tex., Hayti.

Asilus angustifrons. Wash.

Rhadiurgus leucopogon. Neb., S. D.

Zodion obliquefasciatum. S. D., Kan., Tex. to Ariz., Mex., Mont., Wash.

Chelonus angheri. Neb.

Sphærophthalma 4-guttata. Kan., Tex.

Trielis octomaculata. Ark.

Odynerus geminatus. Tex.

Anthophilus pulchellus. Col.

Tachytes texanus. Tex.

It will be seen that the above general list fully bears out the inference drawn from the *Orthoptera* alone that the derivation of this sand fauna is predominantly western. Of 85 species, in all, which are not of general distribution, and which, therefore, according to Morse, are of especial value in studying faunal differentiation. 73 range in some definite direction from the sand region. Less than three percent of these (2 species) can be classed as northern, and neither of these is confined to sandy land. Over 14 percent (11 species) are southern, the increase over the northern species being related to the southward extension of the Great Plains fauna. The range of several on this list seems to be imperfectly defined. Eighteen percent (13 species) are eastern species, one of them (*Sphæridium scarabæoides*) lately introduced, and its western limit carried by this record still farther westward. Several of these are apparently rare species, really of larger range. *Pentatoma juniperina, Chale-*

pus smithi. *Opatrinus notus*. and *Sphæropthalma harmonia*, are probably true eastern species, the *Pentatoma* and *Opatrinus* giving way in the arid region to other dominant species, though the former has lately been found to occur in Colorado. Sixty-four percent (47 species) are western, most of them definitely so, and over 42 percent (31 species) have not even been recorded from any adjacent state.* Four of the *Heteroptera*, however, have each been listed once at the Atlantic coast, three of them in Florida; and there is no apparent reason, except that of greater distance, why the eastern sand areas should not acquire species of the arid West in the same way as is assumed for Illinois.

Several species of the Illinois valley sand region—*Campylacantha olivacea*, *Hesperotettix pratensis*, *H. speciosus*, and *Schistocerca alutacea*—are not rare on the dry soils of the Illinoian glaciation in southern Illinois, and last season (1905) the *Campylacantha* was actually abundant there, in both the western and the eastern portions, on the common *Ambrosia* of that district, *A. bidentata*. These species probably do not exist on the black soil of central Illinois.

The presence in the Illinois valley sand region, as reported by Mr. Gleason, of several characteristic plants of the Great Plains flora, would doubtless attract their own insect fauna, and thus may directly account for the presence of a number of insect species.

Sand as a Factor of Animal Environment.

It has already been stated herein that the presence of sand in the soil has little effect on the fauna—and this is true of the flora also—until the sand reaches a stage of purity which permits it to dry readily and to drift gradually with the wind, in which condition it is called blow-sand; and that except for brief periods at times of rain or melting snow, this is dry and loose at the surface, but always moist a short distance below.

In what way these blow-sand conditions have so marked

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* A comparison of these data with those independently obtained from the flora by Mr. Gleason, on p. 191, second paragraph, will be of especial interest.

an influence on the character of the biota is not very evident. The fact that some organisms are attracted by the presence of others, only complicates the problem. After casting about for species that appeared to be directly influenced by these conditions with the least likelihood of complications of any kind, I selected the acridiid genus *Melanoplus*. Just why *M. flavidus* should occur only in the most barren blow-sand situations while *M. femur-rubrum* seems interdicted by even a suggestion of blow-sand, seems at first sight almost unaccountable. Factors which might possibly have an influence in this case are (1) food supply, (2) moisture, (3) temperature, (4) sparseness of vegetation, (5) the mechanical effect of sand, by its drifting, etc., (6) protection, (7) competition, and (8) the effect of sand on the immature stages.

Considering these factors successively, the matter of food supply might be expected to solve the problem, since McNeill ('91, p. 75, *M. cenchri*) found *flavidus* constantly associated with the sand-bur (*Cenchrus*) which grows on sandy ground; but the sand-bur is locally vastly more wide-spread than *flavidus*, and in our field-work *flavidus* was found in blowouts whether sand-burs were present there or not. Morse ('99, p. 315) says that the food question with grasshoppers is a matter of quantity rather than quality, indicating that they have but little preference as to food supply. As to the subject of moisture, there is doubtless at times much difference between sand and ordinary soil in this respect. Capillary action is stronger in ordinary soil, which therefore dries out more deeply, and at the surface more slowly, than sand; but ultimately one is as dry as the other. The factor of atmospheric humidity at close range with the soil may have some influence upon these geophilous species, as its variations over sand and earth would doubtless be expressed by quite unlike curves. With regard to the direct water supply of these insects it must be remembered that they drink dew only, which is at least not noticeably deficient over our sand regions as compared with prairie soils. The third consideration also, that of temperature, presents only vague possibilities which seem insufficient to limit the local

range of these species. In clear weather the temperature over the blow-sand is probably higher by day and lower at night than in the case of ordinary soil, but the difference in this respect can not be great between some grassy tops of sand-hills occupied by *flavidus* and a close-cropped prairie pasture where *femur-rubrum* abounds. With regard to the sparseness of the vegetation usual on sand-dune tops, this can hardly be an influential factor, as it is not a constant feature of the areas known to be occupied by *flavidus*; and the mechanical effect of drifting or loose sand upon such active insects with so well-developed an exoskeleton, is surely of little consequence to them. As to protective coloration, both of these species are protectively colored. McNeill ('91) notes the strongly imitative coloration of *flavidus* on sand; *femur-rubrum* is slightly darker above than *flavidus*, and therefore better suited to an ordinary soil surface; but, in any case, protective coloration is an effect rather than a cause. Insects which are adapted to obtain food in exposed situations usually approximate the appearance and color of something in their normal surroundings, but surely do not fit themselves in wherever their original coloration matches best. The next factor, competition for space, is suggested in explanation of the limitation to sand of insects such as *flavidus*, the idea being that they are species also fitted for existence in more favored situations, but simply unable to hold their own there in competition with other species such as *femur-rubrum*. The facts of general and local distribution, however, do not support any such idea. Lastly, the effect of sand on the immature stages comes up for consideration. This is an important factor, analogous to taking root and dissemination among plants, and may ultimately prove to have a considerable influence on local distribution; but we have no data as to these stages in *flavidus*. Grasshoppers ordinarily choose a rather hard soil in which to place their egg masses, and excavations in sand are not maintained with the same facility as in earth without special adaptations for the purpose.

In general, therefore, it may be said that while there are a number of minor differences in the biotic environment on

blow-sand and ordinary soil which further observation and experiment may show to have a controlling influence on the local distribution of species, these factors do not, so far as our present information goes, satisfactorily account for the observed peculiarities of specific distribution.

The Relation of Sand and Climate to Insect Coloration.

One of the most evident color adaptations among sand insects is that of direct imitation of the color effect of the sand. The exposed condition of insects upon any surface where the vegetation is more or less scanty makes it advantageous that all species existing there and lacking other means of protection should be as inconspicuous as possible; and species on our list belonging to various orders, have developed remarkably pale dorsal colors, apparently for this reason. In the case of the Carolina grasshopper (*Dissosteira carolina*), which inhabits not only the sand surfaces in this district but also the darker bare surfaces, individuals taken on the sand seemed to show a decided approximation towards its color when compared with those from darker ground in Champaign county. Vosseler, who has studied out and described in detail the fundamental pattern of the *Acridiidæ* ('02, Bd. 17, p. 22), calls attention to the fact that the molting occurs in daylight, and that the nearly colorless fresh exterior is then exposed to the action of reflected rays from surrounding surfaces, which, he suggests, may in some way, by photographic action, produce an approximation to their general color. How this can occur is not clear, but Poulton's experiments on *Lepidoptera*, and various other observations, all point to some such effect. The observations concerning the Carolina grasshoppers above recorded (made before reading Vosseler's paper), and the great differences in the ground color of individuals of this species can be satisfactorily accounted for only in this way.

The more evident examples of sand imitation are the pale brown of *Harpalus testaceus*, *H. erraticus*, and *Geopinus incrassatus*, the broad white markings of *Cicindela lepida* and *Tetragonoderus fasciatus*, the ashy grays of *Stachyocnemis* and *Emble-*

this griseus, the brown color of *Gryllus personatus* and *Udeopsylla robusta*, and the remarkable approximation to sand-color effects in *Trimerotropis citrina*. *Spharagemon wyomingianum*, and other *Acridiidæ*.

The subject of the protective colorations of the phytophilous species is an extensive one, and not closely related to the subject under discussion. The phytophilous, yet undoubtedly xerophilous, green grasshoppers of the genera *Campylacantha* and *Hesperotettix* provoke additional questions as to the environmental factors which limit them to dry soils. *Corimelæna ciliata*, both phytocolous and arenicolous, unless protected by the usual "bug" odor or flavor, may escape its enemies by what Dr. Forbes has called a resemblance to nothing in particular; and apparently the same is true of the *Tenebrionidæ*. It is perhaps going a little too far, however, to tell here that I was once, for a moment, completely deceived on seeing *Rhyssematus lineaticollis* lying in the axil of a milkweed leaf alongside a railroad track, by its exact resemblance to a locomotive cinder.

A type of coloration quite opposed to mimicry is that of the non-sympathetic, or contrasting and conspicuous, colors. Examples of this type are seen in the bright colors—presumably serving as a warning—of certain exposed sand insects otherwise protected, such as the stinging *Mutillidæ* and *Bembecidæ*, the bug *Perillus circumcinctus*, and some of the tiger-beetles (*Cicindelidæ*). A curious fact was noted with regard to the large female mutillid, *Sphærophthalma occidentalis*. This is not rare in southern Illinois and is of the usual bright scarlet color. So also is an example from Meredosia; but the six individuals captured near Havana were all of a faded golden-ochreous tint when taken. The latter locality is about its northern limit, and we have never taken it elsewhere in central Illinois.

Other species are apparently colored in imitation of the preceding class. *Phidippus insolens*, a spider of the blow-sand, is colored and shaped in close imitation of a mutillid. *Laphystia 6-fasciata*, a fly of the blowout pits, resembles a sand wasp (*Microbembex monodonta*) of the same situations both in actions and appearance. *Volucella fasciata*, a very prettily striped syr-

phid fly common in these sand regions, resembles a wasp. A marked case of imitation was that of *Chelonus texanus*, flitting in sparse low vegetation in company with an undescribed *Schizocerus*, and with difficulty distinguishable from it while in action.

The non-sympathetic colors of the *Acridiidæ*, such as those of the hind wings and hind tibiæ, are of unusual interest, especially as they seem to be subject to alteration—to a varying degree in different species but always in the same direction—as the effect of certain climatic influences, apparently that of the degree of humidity, or of humidity and temperature combined.

The bright colors of the hind wings, especially noticeable in the *Œdipodinæ*, are curiously at variance with the modest protective tints of the insect at rest. Vosseler suggests that these rainbow hues, which rival in brightness even those of the *Lepidoptera*, constitute a "contrast-mimicry." While the pursuer is dazzled by the flashing colors, the wings are suddenly closed, and the insect settles quietly to the ground, all track of it being lost in a monotony of color. The genus *Catocala*, among the *Lepidoptera*, is apparently an exactly parallel case. These depend for protection on the close resemblance of the fore wings to the bark of the trees on which they rest. It would seem, however, from the data which follow, that any explanation of the origin of the hind-wing colors of *Orthoptera* should apply to those of the hind tibiæ also.

Bruner ('93) has pointed out that red-winged species—and he might have also said individuals—of grasshoppers are most common in humid regions, and yellow-winged ones in more or less arid regions; that in mountainous regions "just between the dry and wet conditions" blue-winged forms occur; and that from the Atlantic coast to the eastern edge of the Great Plains red or orange is the characteristic color, while on the plains and in other arid districts west and southwest these give way almost entirely to yellow.

In Illinois the hind wings of *Hippiscus tuberculatus* and *H. phœnicopterus* are red, rarely yellow. Those of our common

and only prairie species, *H. rugosus*, and also those of *H. haldemanii*, show a wide variation from bright red to nearly white. The variation is usually discontinuous, there being three or four fairly distinct colors: red, pinkish, yellow, and yellowish white. Our collections of *rugosus* in the Illinois State Laboratory of Natural History, mostly from the humid prairie of central Illinois, were classed as red and yellow. There are 141 *rugosus* in all, 37 red-winged and 104 yellow, the latter number including 46 taken in 1905, of which 15 were clear yellow, and 31, taken mostly on the drier southern Illinois soils, were pale whitish yellow. *Haldemanii* from the sand region in 1905 were 22 red, 1 pinkish, and 9 yellow. *Hippiscus tuberculatus* and *Psinidia fenestralis*, normally red-winged in Illinois, are yellow-winged in the West. The only species variable in wing color and common in both the Illinois sand regions and on the humid prairie are *Hippiscus rugosus* and *Arphia xanthoptera*, but I have not at present a sufficient number of these from each locality for comparison.

The facts at hand warrant the conclusion that while the species of a given locality, and even the individuals of a species, may differ greatly among themselves in regard to wing coloration, the general tendency of arid climates to replace red with yellow and, under certain circumstances, yellow with blue, is too evident to be questioned.

A very similar effect upon tibial coloration is even more evident, and I have taken especial pains to collect evidence on this point. A notable series showing a direct influence of the blow-sand environment—virtually equivalent to climatic influence—upon species within a short distance of each other, is afforded in the genus *Melanoplus* by nearly every active sand-dune examined by us. In the first place, on the least sandy areas in the nearest level cultivated ground, the dominant *Melanoplus* is *femur-rubrum*, always with bright coral-red hind tibiæ. Secondly, on the drier and more sandy grassy ground of the base or lower slope of the dune we find it replaced by *M. atlanis* and *M. minor*. *Atlanis* is here unusually variable in tibial color. Most frequently it is red, as in *femur-rubrum*; sometimes paler,

even pinkish, with bluish at base; or else bluish green, apically yellowish or pinkish, the bluish green varying slightly towards blue or green; or even yellowish. The difference between red or salmon-pink, on the one hand, and the bluish to yellowish tints on the other, is generally well marked. Of 70 specimens of this species quite indiscriminately collected in the sand region, 46 had reddish tibiæ, and 24 were of the blue-green or yellow type—about one third of all, therefore, not being red. The 46 red ones were 23 males and 23 females; the 24 blue-green ones, 11 males and 13 females,—indicating that in this species at least the sexes are evenly divided in this particular. Twenty specimens of *minor* taken, had the tibiæ either greenish blue or coral-red, without intergrades, 12 of these bluish and 8 red. Only five of these were males, all with bluish tibiæ.

Thirdly, on the upper parts of the dunes. where loose sand and tufted growths begin (Pl. XVIII., Fig. 1), these species are replaced by swarms of *M. angustipennis*. This has clear blue tibiæ, rarely coral-red. A continuous search for examples with red tibiæ in this situation yielded only two specimens, both undoubted *angustipennis*, one of each sex. The number of this species taken was 125. Lastly, as one approaches and enters the wind-excavated hollows of the apex, *M. flavidus* becomes most abundant. This invariably has tibiæ of a brilliant and beautiful blue, approaching the shade of cobalt-blue.

In the dense black-jack oak brush which irregularly covers large areas of these sands (Pl. XXI., Fig. 1), four more species of *Melanoplus* are found: *luridus*, *impudicus*. *fasciatus*, and *scudderi*. In comparison with the four open-ground species previously discussed, these four sheltered species confirm the general deductions, as they all invariably had red hind tibiæ. This is true of these species elsewhere, excepting *fasciatus*, of which individuals with pale green tibiæ have been recorded.

In the above comparisons of species from open ground I refer to the colors of local examples from the sand regions only, and an examination of records of the same species for the humid prairie and the sand region of the foot of Lake Michigan,

with its moister atmosphere, at the eastward, and for the more arid western regions, will be of interest.

Femur-rubrum and *atlanis* are common on the humid prairie of Illinois. The tibiæ of the former are always red there, as in the sand region; those of the latter, as shown by a large number of specimens, are about ninety percent red—the rest being green—instead of only two thirds red as in the sand region. Blatchley ('03) says of *angustipennis* in the Lake Michigan sand region, that at least one third had red tibiæ, the rest blue. In a series of 64 specimens, 33 males and 31 females, taken by me near Waukegan, exactly one half have red tibiæ. This is very significant, since red tibiæ were seen in only two out of 125 of the same species in our western Illinois sand regions. The tibiæ of *minor*, according to Blatchley, are usually pale blue, pinkish at tip, sometimes red or dull yellow.

Of these four species in regions to the westward I have found the following records. McNeill ('99) found one female *femur-rubrum* in October in southwest Arkansas with green hind tibiæ. In Texas I have recorded ('06) two such occurrences among only a few specimens seen in the early part of the winter. Scudder ('97) says the hind tibiæ are normally red, occasionally more or less tinged with yellowish, very rarely pale green with a yellowish tinge. Examples with greenish tibiæ are recorded by him from the alpine region of the White Mountains, and from Massachusetts, Utah, Texas, and Mexico. The Massachusetts localities appear to be sandy districts. Gillette ('04) notes that the uniform fuscous-brown of this species in the East becomes in Colorado variably yellow-brown or with bluish tints, in the latter case the tibiæ also often bluish.

As to *atlanis*, Scudder ('97) says the tibiæ are normally rather bright red, not infrequently pale red, green, or yellow, or even dark blue. According to him, examples from the arid West are decidedly paler and more ashy, also those from sandy localities such as the seashore. He records green tibiæ in New Hampshire and Massachusetts at the East, and in Montana, Wyoming, Dakota, Colorado, Nebraska, and Missouri at the West; also blue tibiæ in Iowa, Colorado, Utah, and Texas; but

thinks the red are always in the majority. McNeill ('99) records from Arkansas 39 *atlanis* with red tibiæ and 42 with green. Caudell ('03) found the tibiæ of this species in Colorado to be bright red, yellow, or blue. Cockerell ('89) calls the blue-legged form *cœruleipes*.

Scudder says the hind tibiæ of *minor* are generally nearly uniform in color, usually pale red or glaucous, sometimes plumbeous or yellowish. Dodge ('78) noted "a red-legged variety" in Nebraska, of which he had taken many, but, as in our collections, all were females. As in the previous comparison concerning this species, the evidence is not full enough to be of value here.

Scudder ('97) records only six specimens of *angustipennis*, all from Montana and Nebraska, describing the hind tibiæ as glaucous, feebly lutescent apically; but he has described *M. coccineipes*, with bright red hind tibiæ, from 59 specimens from Utah, Colorado, Nebraska, and Kansas, which is now generally regarded as merely the red-legged form of *angustipennis*. If such it be, then the usual rule seems reversed in this case, and it may possibly be that, after all, the two are not the same species. Gillette ('04) records for Colorado a single male of *angustipennis* and moderate numbers of *coccineipes*, but remarks on the probable specific identity of the two.

The only record of variation in *flavidus* which I have seen, is that of a single otherwise abnormal, doubtful example from Colorado with pale red tibiæ (Scudder, '97).

Melanoplus packardii, a very variable species of wide range west of the Mississippi, has the tibiæ either glaucous or uniform red, according to Scudder ('97). He had 176 specimens. These showed that in this species red tibiæ prevail, perhaps exclusively, at the northward, occurring from British Columbia to Montana, and thence to New Mexico and Kansas. Both red and blue tibiæ are seen in examples from Montana, Utah, Colorado, and Nebraska, and blue only in the specimens from Wyoming, Iowa, and Texas. Bruner ('85) received quite a number of examples of *packardii* from Oregon and vicinity, all of which had the hind tibiæ red, instead of bluish—the usual color

in Nebraska specimens. Gillette states ('04) that the species occurs both on hills and on level ground in Colorado, and of his specimens 69 had red and 58 blue tibiæ. McNeill ('99) found the tibiæ green in southwest Arkansas, red and green in Newton Co., and purplish red in Marion Co. The records of this species indicate that the cooler northern climate has the same effect as a humid climate in favoring the development of red tibiæ.

The Rocky Mountain locust, *M. spretus*, has red tibiæ, and its normal range is from the Saskatchewan towards Colorado and Utah. Examples with pale blue tibiæ (*M. spretus cæruleipes* Ckll.) are recorded from Nebraska by Dodge ('78).

Finally, Scudder has separated *M. bivittatus*, having yellow tibiæ, from *femoratus*, having red tibiæ, but these are almost certainly varieties of one species. *Femoratus* ranges from Nova Scotia and Maine to British Columbia and California, and south to Colorado, Nebraska, Missouri, Illinois, Indiana, Maryland, and North Carolina. It is much the commoner of the two in Illinois, all but 4 out of 133 taken by us in this state being of this variety. *Bivittatus* abounds on the Great Plains, ranging principally from Texas to Utah and Nebraska and, in lesser numbers, from Texas to Ohio, and northward into Canada between Manitoba and the Pacific. The range of these two species accords with that of the two tibial color-varieties of species previously mentioned, indicating that variation in tibial color, which is the only constant difference noted between *bivittatus* and *femoratus*, is not a sufficient basis for specific separation.

Briefly, then, some species of *Melanoplus* have bluish tibiæ only, some red only, regardless of locality, but in other species we find individuals with both kinds of tibial coloration in varying proportions, red on the one hand, and various combinations of blue, green, and yellow on the other, the proportion of the two differing greatly according to species and also according to locality, in all species but possibly one the blue tibiæ increasing with the increase in aridity or in sandiness, except in higher latitudes, and being most numerous east of the Rocky Mountains, from Texas to Nebraska, and least so east of the Mississippi and towards the extreme north.

The details previously given are collated in the following table, in which the figures, when standing alone, represent percentages of individuals of the variety with bluish to yellowish tibiæ, instead of red. Estimated percentages are queried, and dashes indicate lack of data or non-occurrence of species. In the absence of precise data the proportion is expressed by words, or, if unknown, is indicated by the plus mark (+).

DISTRIBUTION AND PROPORTION OF MELANOPLUS HAVING BLUISH TO YELLOWISH HIND TIBIÆ.

Species	Extreme N.W.U. S.	Col.	Tex.	Neb.	Ark.	Ill. Sand	Ill. Prairie	Ind. Sand	East. Sand(?)
femur-rubrum	0	+	2 spms	—	1 spm	0	0	—	+
atlanis	0	+	+	+	52	34	10	—	+ (N.H. &Mass.)
minor	—	—	—	+	—	60	—	usually	—
angustipennis and coccineipes	—	1?	—	9 (Gr't Pl'ns)	—	{ W., 98 E., 50	—	66	—
flavidus	—	100?	100	100	—	100	—	—	—
packardii	0?	46	100	+	50?	—	—	—	—
spretus	0	0	—	1?	—	—	—	—	—
femoratus and bivittatus	+	99?	100	95?	—	—	3	"some"	0

The variation in tibial color has no marked relation to sex. In the small series of *M. minor* at hand the tibiæ are bluish, or in the female sometimes red; in *M. angustipennis* from Waukegan two of every three males have red tibiæ (21 of 33), and two of every three females have them bluish (20 of 31).

This tibial variation belongs to what Bateson calls discontinuous variation, the transition from red to bluish in a series of specimens being more or less sudden. Specimens at the point of change show one color basally and the other apically. This variation is attributed by Cockerell ('89) to an influence promoting or arresting a metabolism of pigment. The order of

the change seems to be, as in the spectrum, from red to yellow, then green, then blue, the intermediate steps between red and green or red and blue being usually absent.

Local Distribution of Species in the Sand Areas. The Insect Associations.

A careful study of the life of a region soon enables one to separate it into biological groups or associations, although in the ultimate analysis nearly every species requires a shelf of its own in the biological classification. It does not seem desirable in this connection to attempt more than a sketch of the insect life of each of the various general types of environment in the sand region. The observations here recorded are given also in the annotated list which follows.

One would not at first sight expect to see much life on the areas of bare sand or with very scanty vegetation, (Pl. X., XIII.–XVI.,) but, in fact, all except the larger entirely barren areas are busy scenes of insect activity, and there seems to be no great change in relative numbers from year to year. The exposed species of the blow-sand may receive attention first. These are largely predaceous. *Cicindela formosa generosa* and *C. scutellaris lecontei* are common everywhere (Pl. XIV., Fig. 1; XV., XVI.), and the light-colored and wary *C. lepida* flits on the bare sand in blowouts (Pl. XIV., Fig. 1. 2). The vertical burrows of their larvæ may be seen opening here and there, and the beetles themselves may be dug out of such burrows in wet weather. *Stachyocnemis apicalis* likes to run over the sand among thin vegetation (Pl. XVI.), and is sometimes seen in excessive abundance. Returning to a locality where it had been thus abundant the day before, rainy weather having set in meanwhile, I could find only one or two anywhere in the vicinity where they had just before been most numerous, and these were hiding under dried horse-dung. Some were once noted apparently feeding on a bit of fresh bird-dropping. *Lepidoptera* are not much in evidence here, except *Eubaphe* and *Crambus haytiellus*, which are not infrequent. In the blowouts (Pl. XIV., Fig. 1) *Microbembex monodonta* and *Laphystia 6-fasciata*

are seen resting on the bare sand and occasionally making a short quick flight. *Bembex spinolæ* is occasional. The *Bembecidæ* oviposit in burrows in the sand and provision them with flies. The red female *Mutillidæ* are conspicuous as they walk hurriedly along, presumably in search of insects with which to stock their nests, often followed by the black, winged males. (Pl. XIV., Fig. 1; XV., XVI.) Predaceous flies, *Anthrax* and *Asilidæ*, the latter including *Laphystia*, are common, resting on the sand or flying about. (Pl. XIV., Fig. 2; XVI.) Those alert personifications of incessant activity, the *Ceropalidæ*, flit rapidly along near the ground amongst the vegetation, (Pl. XVI.,) searching for spiders for their nests, and if the spider *Phidippus insolens* did not look so much like a female mutillid it might not be able to assume the manner which gives it its specific name. Of course the grasshoppers are a conspicuous feature of the blow-sand, *Melanoplus flavidus* and *M. angustipennis* and the bright-winged *Œdipodinæ*—such as *Spharagemon wyomingianum*, *Hippiscus*, *Psinidia fenestralis*, and others—jumping about or flying here and there over the bare sand. (Pl. XIV., Fig. 1; XV., etc.)

Logs, boards, dried dung, and other shelters are not very common on the sand prairie, but underneath them we find a second and very interesting group of insect associations. At the Devil's Neck we have found *Gryllus personatus*, *Nothopus zabroides*, *Ceuthophilus* sp., *Geopinus incrassatus*, *Cratacanthus dubius*, *Harpalus caliginosus*, *Anisodactylus rusticus*, *Termes flavipes*, and others, the *Carabidæ* all quite abundant. In June many *Nothopus* were found here, but all were dead. Under bark and sticks on sand under trees (Pl. XX., Fig. 2) were *Ischnoptera inæqualis*, *Udeopsylla robusta*, and some curious cydnid nymphs. Beneath boards on very sandy pasture land were *Lacon rectangulus* and *Opatrinus notus* in abundance, also *Harpalus testaceus* and *H. erraticus*, the latter commonest. Under the remnants of a dead animal in a blowout were *Trox scabrosus* and *Canthon nigricornis*.

A third group are the burrowers in bare sand, among which are the tiger-beetles and their larvæ and various *Hymenoptera*.

The ant-lions made their obconic pits wherever they could secure protection from rain, and waited at the bottom for an unwary insect to walk into the trap. A tiny surface-burrow in open sand, like that of a mole, was made by a small carabid larva. The most curious work seen, was that of a small active microlepidopterous larva, which webs together a tube of sand, usually beginning at the base of a plant, and extending it long distances (two or three feet), up to the tops of the stems. We have found these web tubes on *Onagra* and several other herbaceous plants. The adult was reared by Mr. J. J. Davis, and named by the Bureau of Entomology *Olethreutes dimidiana*. Discrepancies in the biology of that species and ours lead us to think that an error has crept in somewhere. The web closely resembles that of *Prionapteryx nebulifera*, described and figured by Daecke ('05), which he found on huckleberry and sand myrtle growing on white sand in New Jersey; but Mr. Daecke has seen our larva, and says it is not the same as his.

Turning now to the tufted and moderately dense vegetation of the neighboring areas of open waste land, too sandy for cultivation or even for pasturage (Pl. XVIII., Fig. 1), there is found an apparently inexhaustible variety of insect life. Grasshoppers swarm everywhere here. *Melanoplus angustipennis* is as numerous here as *M. femur-rubrum* on the prairie pastures. *Ageneottetix scudderi*, *Psinidia*, and *Trachyrhachis*, as well as the more familiar *Dissosteira* and *Hippiscus rugosus*, are seen in fall, and *Hippiscus phœnicopterus* and *H. haldemanii* in June. About the Devil's Neck, *Amphitornus bicolor*, a species of the Great Plains, was now and then taken in such ground. In short growths of coarse grass at the Moline Sand Hill were large numbers of *Orphulella speciosa*. Upon the vegetation of the waste areas mentioned were *Œcanthus 4-punctatus*, *Bacunculus blatchleyi*, and *Conocephalus robustus*,—the latter, head down, simulating a grass leaf,—also *Campylacantha*, *Neottiglossa sulcifrons*, and a host of others. The *Campylacantha* was not confined here to *Ambrosia bidentata*, upon which we uniformly found it in southern Illinois. Here ant-lion adults fluttered

weakly about. The song of *Cicada marginata*, resembling that of the periodical cicada, was heard; and in the twilight came the penetrating shrilling of *Conocephalus robustus*, and the rattling note of the male of *Heliocheilus paradoxus*, as moths of the latter species danced in groups here and there.

The abundant wild flowers were visited by large numbers of bees, wasps, and other aculeate *Hymenoptera*, many of which were species rarely or never seen on the prairie,—*Dielis plumipes*, for example,—probably associated with the unusual flora. Families which nest in sand were well represented, such as the *Larridæ*, which capture young *Orthoptera* to provision their nests, the *Bembecidæ*, which use flies for this purpose, and the bee family *Colletidæ*. In fact, this kind of region seems particularly favorable to the development of these insects in great numbers and variety because of the undisturbed ground and vegetation in addition to the character of the soil. Hoppner ('01) shows that similar conditions prevail in a tract of dune sands along the Weser valley in Germany, finding there six characteristic local species of bees, and three others more abundant there than elsewhere, the total list including two thirds of all the bees found in northwest Germany. To develop this subject for our district would require vastly more time than was available.

The insects associated with some of the more common plants of the sand region may next be grouped under their respective plants.

Mesadenia atriplicifolia.—This may well head the list of host plants, with its interesting insect guests. On the flowers of scattered clumps of these plants were two far western species, a large tenebrionid (*Epitragus acutus*) and a long-legged reduviid (*Zelus socius*), also *Lygæus bicrucis*, and, upon the stems, *Languria bicolor*, the larvæ of which burrow in the stems.

Opuntia humifusa.—This cactus was usually abundant, and sometimes supported flourishing colonies of *Pentatoma juniperina*. It was also responsible for the presence of the bright-yellow-striped chunky little syrphid fly, *Volucella fasciata*, seen

feeding in the flowers of various plants, as its larva lives in the cactus flesh. *Collops tricolor*, *Acmæodera tubulus*, and *Strigoderma arboricola* were noted within the flowers.

Onagra biennis.—In addition to the larva of the web tube previously mentioned, this was fed upon by *Attelabus bipustulatus*, *Haltica fuscoænea*, *Tyloderma foveolatum*, and *Chalcodermus collaris*, and often harbored a number of adult *Metachroma parallelum*.

Monarda punctata.—This abundant plant of the sand regions about Havana was seen at different times to have its stems dotted with *Corimelæna ciliata* and *Sehirus cinctus*. The *Corimelæna*, usually considered quite a rare species, was also extremely abundant in nearly bare sand about the bases of little grass tufts, every turn of the finger in the sand bringing several to the surface. Honey-bees were common upon the flowers of the *Monarda*.

Commelina virginica.—The leaves of this plant were white-streaked by the feeding of adults of *Lema cornuta*. the larva of which bores in the stems.

Rhus aromatica.—This dense, bushy sumac (Pl. XIX.) supported *Blepharida rhois* and its sticky larvæ, *Perillus circumcinctus*, and *Resthenia insitiva*. *Catorhintha mendica* and *Zelus socius* also occurred on it.

Euphorbia corollata.—*Chariesterus antennator* was once noted very common on flowers of this species.

Cassia chamæcrista.—This common flowering plant of the waste sand land was well populated. *Bombus*, *Apis*, *Plesia* (*Myzine*), *Polistes*, etc., were busy on its flowers, and *Phormia terrænovæ* was numerous about it. *Bruchus cruentatus* was swept from it in numbers, probably breeding in the seeds.

Cracca virginiana.—A group of these plants was infested with *Macrobasis unicolor*.

Callirhoe triangulata.—This formed a sprangling tuft of stems and long-petioled radical leaves, and at their extreme bases, within the tuft, were often large enveloping masses of "frog-spittle", containing bulky blackish larval *Cercopidæ*, prob-

ably *Lepyronia sordida*, the adult of which was taken on this plant.

Euthamia sp. (*Solidago*).—In a small patch of this plant the phytophilous *Hesperotettix pratensis* was quite abundant.

Along the railroad track near Forest City, *Phacepholis candida* was abundant on some undetermined low weeds.

For the concluding group of inhabitants of the open waste sandy land I may appropriately mention our herpetological observations in this region, which cover all the characteristic vertebrates noted. There were four of these: the box-turtle (*Cistudo carolina*, Pl. XII., Fig. 2), the striped lizard (*Cnemidophorus sexlineatus*), the hog-nose snake (*Heterodon simus*), and a small *Hyla*, or tree-toad. Ten years ago the box-turtles were quite common at the Devil's Hole, but I have seen very few of late years. The striped lizard ranges throughout the valley, and is not rare here. The hog-nose is quite common, especially along roadsides and sandy shores.

The general arid aspect of the sandy regions is relieved by the moist growth at the bottoms of deep wind-excavations in the sand, and here a very different fauna obtains. Adults of aquatic neuropteroids, such as *Hexagenia* and various dragonflies, rest on plants here or fly about; *Locustidæ* and their nymphs suddenly come into prominence,—for example, *Xiphidium*, *Scudderia*, and *Amblycorypha uhleri*; and moisture-loving grasshoppers, such as *Dichromorpha viridis* and *Orphulella pelidna*, replace those of the dry sand. A variety of rare and interesting *Hemiptera* occurred on this vegetation; for example, *Homæmus æneifrons*. Long grass on the sides of hollows of this kind was well populated with elongate tryxaline grasshoppers, *Mermiria bivittata* and *neomexicana* and *Syrbula admirabilis*, the latter in the drier and sparser portions.

The sandy roadways have some fairly definite insect associations. Here *Aphodius rubeolus*, *Canthon lævis*, *Onthophagus hecate*, and *O. pennsylvanicus* are found at the usual occupations of these genera; *Anthrax*, *Erax*, and *Cicindela formosa generosa* and *scutellaris lecontei* fly along the bare wheel-track lines; *Ammophila* is common, and *Megachile latimanus* and *Epeolus lunatus*

bunch up in cool or rainy weather on the dead weed stems; while the border of dandelions and sweet clover is visited by numbers of *Volucella fasciatus*, *Dielis plumipes*, *Agapostemon splendens*, etc. In the level and least sandy roads are found *Melanoplus femur-rubrum* and *Cicindela punctulata*, and, under boards, along the fence lines, *Gryllus pennsylvanicus*, *Carabus sylvosus*, etc.

Culture of various kinds accounts for the presence here of the potato-beetle, box-elder bug, chinch-bug, potato stalk-borer, and house-fly, and of the male of *Blatta orientalis* at an electric light. In a street at Forest City, adults of *Lucanus placidus* were coming to the surface at the base of shade trees along the walks.

Taking up now the forested ground, a situation claiming especial attention is the very sandy black-jack land, with its matted scrubby growth (Pl. XXI., Fig. 1), whose contribution to our list of sand insects was by no means small. The characteristic grasshoppers here were *Melanoplus luridus*, *impudicus*, *scudderi*, and *fasciatus*, and *Chloealtis conspersa*. Along the roads were *Hippiscus phœnicopterus* and *Schistocerca alutacea*, (Pl. XVIII., Fig. 1.) which latter liked to fly up into the oak brush when disturbed. *Calopteron terminale* and *C. reticulatum* were common. The stalks of *Scrophularia nodosa* were loaded with *Cosmopepla carnifex* in June, and small oak sprouts had at that time a great many small click-beetles (*Limonius quercinus*) on leaves and stems.

The marginal sand ridge, with leaf-mold and a better developed forest (Pl. XXI.,Fig. 2), had about the usual central Illinois fauna for forest situations.

Finally, the long stretch of moist sandy shore (Pl. XXIII.) extending from Quiver Lake to Riverside Park, a distance of about three miles, added new elements to the sand fauna, partly due to the presence of the river and partly to the sand, and seeming but doubtfully eligible to a place in these studies. The river-shore-sand grasshopper, *Trimerotropis citrina*, whose habitat extends in a slender strip along the southern seashore and up each shore of our larger rivers, is here in evidence, as usual.

Along the narrow strip of wave-washed beach at the foot of the sand bluff were great numbers of tiger-beetles, *Cicindela cuprascens* and *C. hirticollis*, also *Paratettix cucullatus*. *Bembidium* was found along the water margins. Under the driftwood were *Chlænius sericeus*, *Patrobus longicornis*, *Platynus octopunctatus*, and other *Carabidæ*, also *Gryllus pennsylvanicus*. In the drier sand higher up we have noted *Tetragonoderus fasciatus* and *Blapstinus interruptus*. Under and about dead fish, turtles, etc., are found *Saprinus*, *Hister*, *Silpha*, and *Cercyon*, often in great numbers. *Anthrax* and *Bembex* are also common, flying about on the dry sand. Among the insects on plants along the sandy beach in June, and conspicuous by reason of their great abundance, were the daddy-long-legs (*Liobunum*) on mulleins and other plants, and *Metachroma angustulum*, *M. parallelum*, and *Melasoma lapponica* on willow. Even on straggling willows and poplars among the sand hills inland (Pl. XX., Fig. 1), both species of *Metachroma* were very numerous, and *M. parallelum* abounded also on a variety of plants. There is no previous record of their occurrence this side of Kansas except that of *parallelum* by Brendel ('87) in this same region. *Disonycha 5-vittata*, very variable in markings, was also taken on willow among the sand-hills.

Annotated List of Species.

The following list includes all species taken within the limits of the western Illinois sand regions. No attempt to restrict it has been made, since few faunal lists have as yet been published for Illinois. The determinations are my own except as otherwise stated, and much time and pains have been taken to make them accurate.

I am under obligations for help in securing determinations to Dr. L. O. Howard, Professor Herbert Osborn, Mr. W. S. Blatchley, Mr. A. L. Melander, Mr. E. S. G. Titus, and Mr. Frederick Knab, and their cordial coöperation is gratefully acknowledged. My friend and collaborator, Mr. Gleason, has helped me with the plant names. Mr. J. J. Davis and Mr. R. O. Johnson, of the University of Illinois, who accompanied me on the field

trip of June, 1905, have very generously permitted the free use of their collections and notes in this connection. The fulness of the records for Meredosia and the Moline Sand Hill are due in no small degree to the keen discrimination and enterprising activity of my field assistant, Mr. Frank Shobe. The extensive collections and excellent library of the State Laboratory of Natural History, and the Bolter Collection of Insects at the University of Illinois have been especially useful to me. The entire series of specimens collected has been turned over to the State Laboratory.

For each species the sand region localities and dates are given, so far as known, and usually, in parenthesis, the number of specimens taken, if more than one, followed by biological notes or other items of interest. The systematic notes (unless very brief), including descriptions of new species, appear under a separate heading at the end of the list, and are referred to by number. Finally, the distribution of the species in Illinois outside the sand regions is given, data being derived from the State Laboratory collections, the Bolter Collection, and published lists, supplemented by my own observations. The source is cited only in case of the Bolter Collection and published lists. The exact known distribution of the rarer species is given in full; the more common ones are followed simply by "Ill.", or, if known to be of general occurrence throughout the state, by "All Ill." The most important of the published lists referred to are those of Mr. Charles Robertson for Carlinville, of Dr. Brendel ('87) for Peoria, of the Chicago group of entomologists (see Kwiat, '05), of McNeill ('91—Illinois *Orthoptera*), of Melander ('03—*Mutillidæ*), of Wolcott ('95–'00—central Illinois *Coleoptera*), and of H. Garman ('92—*Amphibia* and *Reptilia*. The distribution outside of Illinois of species of restricted range has already been given under "Geographical Distribution".

The main Illinois Valley sand region (see map) extends from our southernmost locality, Meredosia, which is about eighty-five miles north and a little west of St. Louis, to near Peoria, about an equal distance northeast of Meredosia. Our northernmost locality is the Moline Sand Hill, in the Rock River

valley, northern Illinois, about eighty miles northwest of Peoria. Collections in the Illinois River area are cited from Teheran, at the eastern border of this area, fifteen miles east of Havana, from Pekin, ten miles below Peoria, from Matanzas Lake, eight miles below Havana, and from the sand beach of Thompson Lake, in Fulton county, opposite Havana; but especially from six principal regions in the vicinity of Havana, designated by numerals. Those who care for topographical rather than geographical detail may note that H.1, 2, and 3 are the three principal blow-sand areas, counting from north to south and in order of sandiness; that H.3 has a large admixture of areas of black-jack growth; that H.4 and 5 represent forest on sand; 4, the newer growth (black-jack), with some open ground; and 5, the older and more varied forest, approaching ordinary Illinois forest conditions with a little open sandy ground; and that H.6 is the immediate sandy river beach and lake beach along the western margin of the sand plain. For convenient reference, the principal details with regard to these various localities are summarized as follows:

H.1 = the Devil's Neck, ten miles north of Havana, open land, a large area of barren sands and blowouts, approached by sandy roads. (See p. 197, and Pl. XII., Fig. 1; XIV., Fig. 1; XX., Fig. 1.)

H.2 = the Devil's Hole, two miles east of Havana, similar to H.1 but smaller. (See Pl. XIII.; XIX., Fig. 1; XX., Fig. 2.)

H.3 = a large area of rolling sand-hills with occasional blowouts, considerable waste sandy open land, and areas of scrubby black-jack forest, lying south and southeast of Havana. (See Pl. VIII.–XI., XV.–XVII.)

H.4 = the east margin of the sandy postglacial island northeast of Havana near the center of which is the Devil's Neck. This margin is mostly covered with black-jack. (See Pl. XXI., Fig. 1.)

H.5 = the marginal sand ridge just above Havana, mostly covered by comparatively well-developed forest growth. (See p. 198, and Pl. XXI., Fig. 2.)

H.6 = the sandy beach, moist near the water level, extending for a mile or two along the river and lakes just above and below Havana. (See p. 198, and Pl. XXIII.)

H.m. = miscellaneous situations about Havana.

Mer. = a very sandy small area, with blowouts, some black-jack, sand-pit, and adjacent sandy river bank, just south of Meredosia. Ill. (See p. 198.)

Mol. = the Moline Sand Hill, on the left bank of the Rock River near Moline, with a small summit area of waste sand land, and blowouts, adjoining a close-cropped sandy pasture. (See p. 198.)

For the sake of brevity, Je., Au., and S. are used respectively for June, August, and September.

ARACHNIDA.

Phidippus insolens Hentz (Banks, det.). H.1, 4, Mer.; Je. 6, 7, Au. 20, 22, 29. (8) Blow-sand and dune tops. Mimics female *Mutillidæ*.

Acrosoma rugosa Emerton (Banks, det.). H.5, Au. 12.

Wala mitratus Hentz (Banks, det.) H.2, Au. 18.

Tetragnatha laboriosa Hentz (Banks, det.). H 2, Au. 18.

Xysticus gulosus Keys (Banks, det.). H.2, 4; Je. 6 (immature), Au. 18. (5)

Liobunum vittatum Say (Banks, det.). H.2, 6; Je. 9, Au. 12, 18, 19. (11) Abundant on mullein along river bank All Ill.

Trombidium locustarum Riley. H.2, Au. 19. (2) On *Melanoplus angustipennis*.

PLATYPTERA.

Termes flavipes Kollar. H.2, 5; Au. 17, 19. (8) Common on the under part of sticks and logs on sand. Observed swarming from a house in Havana. Ill., especially southward.

ORTHOPTERA.

Ischnoptera inæqualis Sauss.-Zehntn. H. 1,2, 4, 6, H.m.; Je. 7, 8, 9, 12, Au. 18, 19, 20, 22. (11) All Ill., common; Iowa.

Blatta orientalis Linn. H.m., Je. 18, 25. (2) Ill.

Bacunculus blatchleyi Caud. H.1, Au. 22. (2) On dry prairie vegetation. All Ill., not rare; L. Geneva, Wis. (Note 1)

Tettix arenosus Burm. H.6, H.m.; Apr. 13, May 6, Je. 8, 9. (6) All Ill.

Paratettix cucullatus Burm. H 6, Mer.; Je. 9, Au. 29. Nymphs, Je. 8, 9. (9) Moist shores. All Ill.

Mermiria neomexicana Thom. H 2, 4, Teheran; Au. 18, 19, 20, S. 2. Nymph, Au. 17. (38) With the next species among long bunch-grass (*Panicum virgatum*) in old blowout between dunes. No other Illinois records.

Mermiria bivittata Serv. H.1, 2, 3, 4, Mer.; Au. 12, 13, 14, 18, 22, 30, S. 2. (31) With the preceding; also in patch of *Cracca*. Tamaroa (S. Ill.), long grass on summit of Mississippi R. bluff at Chautauqua, Ill., near Grafton, July 20.

Syrbula admirabilis Uhl. H.2, 3, 4, Teheran, Mol.; Au. 12, 17, 18, S. 8. Nymphs, Au. 19, 20. (17) All Ill., dry grassy ground.

Eritettix virgatus Scudd. H.4, Je. 6. (Note 2)

Amphitornus bicolor Thom. H.1, 4; Au. 20, 22. Nymph, Je. 7, 23. (8) Grassy dune summits near middle of postglacial island. No other Illinois record.

Orphulella speciosa Scudd. H.4, Mol.; Au. 20, S. 8. (61) Common in short dense grass on sand at Moline Sand Hill; rare in Havana region. All Ill., especially on dry soils; taken at lights.

Orphulella pelidna Burm. Mer., Au. 30. Moist bottom of sand-pit. Swales between sand ridges, Waukegan.

Dichromorpha viridis Scudd. H.1, 2, 5; Au. 12, 17, 18, 22. (7) Moist grassy bottoms of old blowouts; old forest. All Ill.

Chloealtis conspersa Harr. H.3, 4; Au. 14, 17, 20. (5) C. Ill. and northward.

Ageneotettix scudderi Brun. H.1, 2, 3, 4, Mol., Mer.; Au. 12, 13, 17, 18, 22, 29, 30, S. 2, 8. Nymphs, Je. 5, 7. (91) Abundant in all blow-sand areas. "Near Moline, where it seems to be confined to a few sandy hilltops along the Mississippi R." (McNeill). Waukegan, sandy ridges near L. Michigan. (Note 3)

Mecostethus lineatus Scudd. Matanzas L., July 6. At margin of sand plain, probably in bottom-land. In bog, Lake Co., Ill., Au. 13.

Mecostethus platypterus Scudd. Teheran, Je. 22. Low ground on glacial flood-plain. Champaign, July 31, dense grass in wet ground. Ill. (Coll. O. S. Westcott) Hitherto known only from New England, but these are typical examples of the species as characterized and figured by Morse ('96) and McNeill.

Arphia sulphurea Fabr. H.1, 4, 6; Je. 6, 7, 9, 23. (10) Open woods, all Ill., early summer.

Arphia xanthoptera Germ. H.1, 4, Mer.; Au. 20, 22, 30. (5) Roadsides, in black-jack. Dry woods, all Ill.

Encoptolophus sordidus Burm. Mol., S. 8. Ill., especially northward, on dry open ground.

Hippiscus tuberculatus Palis. H.4, Je. 6. C. Ill. and northward; infrequent.

Hippiscus phœnicopterus Germ. H.1, 4; Je 5, 6, 7, 23. (43) Common on grassy dunes and along roadsides in black-jack in early summer, with the next species. S. Ill., in dry open woods on hillsides.

Hippiscus haldemanii Scudd. H.1, 2, 4; Je. 6, 7, 8, 23. (21) Common in the sand region, associated with the preceding species. On Rock Island (McNeill, *tuberculatus*, *fide* Scudder). The intercalary vein in *Hippiscus*, especially in this species and *phœnicopterus*, is quite prominent and bears a row of minute tubercles, as in *Mecostethus*: and the upper carina of the internal face of the hind femur is rubbed against it, causing a distinct rasping stridulation. The sound may be easily produced in this way in freshly killed individuals. In all the *Œdipodinæ* of this list the same structure of the intercalary vein occurs, and presumably also the same habit of stridulation by means of it when not flying. Regan ('03) has described and figured (Pl. I., Fig. 3) this method of stridulation in *Psophus*. Morse ('96) has noted the general occurrence of this structure in the *Œdipodinæ*, and has seen and heard the stridulation in *Circotettix verruculatus* and *Encoptolophus sordidus*.

Hippiscus suturalis Scudd. Mol. (McNeill, *rugosus*).

Hippiscus rugosus Scudd. H.1, 2, 3, Teheran, H.m.; Au. 13, 17, 18, 22. Nymph, Au. 18. (16) Lower slopes of dunes. All Ill.

Dissosteira carolina Linn. H.2, 4; Au. 12, 18. Nymph, Au. 20. (3) Roadsides. All Ill., bare ground of roads, etc.

Spharagemon bolli Scudd. H.1, 2, 3, 4, Mer.; Au. 13, 17, 20, 22, 30. (7) In older dry forest, occasional in black-jack. All Ill.

Spharagemon wyomingianum Thom. H.1, 2, 3, 4, 5, Mol., Mer.; Je. 23, Au. 12, 13, 14, 17, 18, 19, 20, 29, 30, S. 2, 8. Nymph,

Au. 20. (76) Abundant everywhere on sand in open ground. Waukegan, sandy ridges near L. Michigan.

Mestobregma thomasi Caud. H.1, 2, 3, 5, Mol.; Au. 17, 18, 19, 22, S. 2, 8. (13) Common on the dunes. Throughout S. Ill., on dry barren ground. (*Trachyrhachis thomasi* in text.)

Psinidia fenestralis Serv. H.1, 2, 3, 4, 5, Mol., Mer.; Au. 12, 13, 14, 15, 17, 18, 19, 20, 22, 29, 30, S. 2, 8. Nymph, Au. 18. (85) Abundant everywhere on the blow-sand; wings rose-red. Waukegan, sandy ridges near L. Michigan. (Note 4)

Trimerotropis citrina Scudd. H.2, 6, Mer.; Au. 12, 29, S. 5. (12) Sandy shores of Ohio, Mississippi, and Illinois rivers in Illinois; one taken at Devil's Hole. "N. Ill." (Note 5)

Schistocerca americana Drury. H.m. Seen with *Locustidæ* in soft grass in moist bottom of old blowout. C. and S. Ill.

Schistocerca alutacea Harr. H.2, 3, 4, Mol., Mer.; Au. 14, 15, 17, 18, 20, 29, 30, S. 2, 8. Nymph, Au. 20. (69) Common along the margins of black-jack forest and about thickets and bunch-grass; roadsides. Dry soils of the Illinoian glaciation in S. Ill., and a few restricted localities in N. Ill.: swales between sand ridges, Waukegan.

Campylacantha acutipennis Scudd. H.4, Mer.; Au. 20, 30. (2) Found associated with the next species, but in much fewer numbers. Perhaps only a dark grayish variety of it. Clay Co.

Campylacantha olivacea Scudd. H.1, 2, 4, Mer.; Au. 18, 20, 21, 22, 29, 30, S. 2. Nymph, Au. 18. (19) On the grassy dunes, moderately common. Abundant on *Ambrosia bidentata* on the dry soils of the Illinoian glaciation across southern Illinois.

Hesperotettix pratensis Scudd. H.3, Au. 18. (17) On a patch of *Euthamia* (*Solidago*) in a basin among sand-hills. Taken in southern Illinois along the I. C. R. R.: swales among sand ridges, Waukegan; long grass on summit of Mississippi R. bluff at Chautauqua, Ill., near Grafton, July 20.

Hesperotettix speciosus Scudd. H.1, 2, 3; Au. 18, 22, S. 2. Nymph, Au. 22. (4) Occasional with *Campylacantha olivacea*. Taken on the dry soil of the Illinoian glaciation in southern Illinois.

Melanoplus flavidus Scudd. H.1, 2, 3, 4, 5, Mol., Mer.; Au. 12, 13, 14, 18, 19, 20, 22, 29, 30, S. 2, 8. Nymphs, Au. 17, 18, 19, 20. (51) Common everywhere in blowouts and on very sandy ground. Not taken elsewhere in Illinois. Associated by McNeill with the sand-bur (*Cenchrus*), but it is apparently an

accidental relation, and not invariable. Mr. J. D. Hood has shown me examples taken near Lone Rock, S. W. Wis.

Melanoplus atlanis Riley. H.1, 2, 3, 4, 5, Teheran, Mol.; Je. 6, 7, 8, Au. 12, 14, 17, 18, 19, 20, 22, S. 5, 8. (72) Moderately sandy ground. Dry sandy or gravelly places in N. and C. Ill.; general and abundant in S. Ill.

Melanoplus impudicus Scudd. H.3, 4; Au. 14, 17, 20. (4) Occasional in black-jack. Common on high rocky slopes of Ozark Ridge in S. Ill.

Melanoplus scudderi Uhl. H.1, 3, 4, Mer.; Au. 17, 20, 22, 30. (6) Roadsides in black-jack, and occasional elsewhere on sand. All Ill.

Melanoplus fasciatus Barnst. H.4, Au. 20. (11) On dry floor of fallen leaves in black-jack. Also in similar localities in eastern and southern Illinois.

Melanoplus femur-rubrum DeG. H.1, 2, 3, 4, Teheran: Au. 15, 17, 18, 20, 22, S. 2. (32) On the level areas with coating of soil. All Ill., least common in southern part.

Melanoplus angustipennis Dodge. H.1, 2, 3, 4, Mol., Mer.; Je. 23, Au. 12, 13, 14, 15, 17, 18, 19, 20, 22, 29, 30, S. 2, 8. Nymph, Au. 19. (122) Very abundant everywhere on waste sandy land. Commoner than *flavidus*, even at the Moline Sand Hill, but not recognized by McNeill as distinct from his *cenchri* (*flavidus*). Waukegan, sandy ridges near L. Michigan.

Melanoplus macneilli, n. sp. Mol., S. 8. (19) With *angustipennis* and *flavidus* at edge of large blowout at east end of the sand hill. (Note 6)

Melanoplus minor Scudd. H.1, Je. 7. (20) In sandy corner of close-cropped grassy pasture in early summer. No other Illinois record.

Melanoplus luridus Dodge. H.2, 3, 4, Mer; Au. 14, 17, 18, 20, 30. (31) Common in black-jack. Also on dry, barren, high, wooded hilltops in Illinois, and, at Waukegan, on sandy ridges near L. Michigan.

Melanoplus differentialis Uhl. H.2, 3; Au. 15. Nymph, Au. 18. (2) Roadside, level ground. All Ill.

Melanoplus bivittatus femoratus Burm. H.1, 2, Teheran; Au. 13, 17, 18, 22. (6) Low ground, roadsides. All Ill.

Phœtaliotes nebrascensis Thom. H.4, Au. 20, nymphs and adults. (7) Rock Island region (McNeill, '91. *Pezotettix autumnalis*).

Dry sandy ground; also along swales between sand ridges near Waukegan.

Scudderia texensis Sauss.-Pict. H.2, 3, 4; Au. 14, 17, 18, 20. (6) Lower slopes of dunes, not uncommon. All Ill.

Scudderia furcata Brunn. H.3, 4; Au. 18. Nymph, Au. 20. (2) All Ill.

Amblycorypha uhleri Stal. Mer., Au. 30, in damp sand-pit. S. Ill.

Conocephalus robustus Scudd. H.2, 4, 5; Au. 11, 12, 18, 20. (4) Waste sandy land. Observed resting, head downward, on a grass stem, closely resembling a grass leaf. Its long-continued, penetrating shrill call is heard on all sides at dusk. Dry places in C. and S. Ill.

Xiphidium strictum Scudd. H.2, 4, Mol.; Au. 18, 20, S. 8. (7) One of the two from the Moline Sand Hill was long-winged. Common in damp grassy bottoms of old blowouts. Ill.

Xiphidium brevipenne Scudd.? Nymph, H.4, Au. 20. Ill.

Orchelimum, sp. Nymph, H.4, Au. 20.

Ceuthophilus, sp. H.1, Je. 7. Injured specimen; taken under fallen tree in blowout.

Udeopsylla robusta Hald. H.2, 5; May 17, Je. 8. (2) Under logs. No other Illinois records. (Note 7)

Nemobius fasciatus vittatus Harr. H.1, 4, Mol., Mer.; Au. 20, 22, 30, S. 8. (9) On sandy ground and elsewhere. All Ill. (Note 8)

Nemobius carolinus Scudd. Thompson L., S. 1. (6) On moist sandy beach under sticks among trees. All Ill., in damp woods.

Gryllus abbreviatus Serv. H.6, S. 5. (15) Under driftwood on dry sandy shore. Ill., in fall.

Gryllus pennsylvanicus Burm. Short-winged form, H.1, 2, 4,; Je. 6, 7, 8, 9, Au. 20. (13) Long-winged form, H.2, H.m.; Je. 7, 8. (6) Under sticks, boards and leaves on sand, and at electric light. Ill., mostly in summer.

Gryllus personatus Uhl. (Blatchley, det.). H.1, 2; Au. 19, 22. (3) Under logs in blowouts. Nymphs only, but mature enough for determination. No other Illinois records.

Œcanthus niveus DeG. H.4, nymph, Je. 23. Ill.

Œcanthus pini Beut. H.6, S. 4. (2) Ill.

Œcanthus 4-punctatus Beut. Mol., S. 8. (4) On vegetation. Ill. in fall.

Hemiptera.

Cicada dorsata Say. H.4, Au. 20. (2) Flying on open grassy summit of sand ridge. Tamaroa and Urbana.

Cicada marginata Say. Mol., S. 8. S. Ill., common.

Cicada tibicen Linn. H.m., Au. 17. Ill.

Tettigia hieroglyphica Say. H.1, H.m.; Je. 23, July 2. (2) Entered car window while train was passing through sand region. No other Illinois record.

Chlorochara conica Say. H.2, 4; Au. 19, 20. (2) Ill.

Scolops grossus Uhl. H.2, Au. 12, 18. (4) Ill.

Philænus lineatus Linn. H.4, Je. 6. (3) On vegetation of waste open sandy land. No other Illinois record.

Lepyronia gibbosa Ball. H.1, 4; Je. 6, 23, Au. 20. (7) On *Callirhoe triangulata*, etc. Also from Dayton (N. Ill.). A sand-hill species in Nebraska.

Cercopidæ, sp., immature. H.1, 4, 6; Je. 6, 9, 23. (11) Numerous on bases of radical leaves and stems of *Callirhoe triangulata*, each in mass of froth. Perhaps young of preceding species.

Deltocephalus melsheimeri Fitch. H.4, Je. 6. (2) Ill.

Agallia sanguinolenta Prov. H.4, Je. 6. (2) Ill.

Ceresa bubalus Fabr. H.5, Teheran: Au. 17. (2) Ill.

Stictocephala lutea Walk. H.4, Je. 6. Ill.

Ophiderma salamandra Fairm. H.4, Je. 6. Ill.

Campylenchia curvata Fabr. H.5, 6: Je. 9, Au. 17. (2) Ill.

Lecanium, sp., immature. H.2, Au. 19. (6) Common on stems of *Cycloloma atriplicifolium* in road.

Diommatus congrex Uhl. (Osborn, det.). H.6, Je. 8.

Tinicephalus simplex Uhl. Teheran, Au. 17. Vegetation along railroad. Ill.

Malacocoris irroratus Say. Teheran, Au. 17. (2) With the preceding species. Ill.

Lygus pratensis Linn. H.2, Au. 19. Ill.

Phytocoris colon Say. (Osborn, det.). H.4, Je. 5. (3) On plants by roadside.

Resthenia insitiva Say. H.1, 2, 4; Je. 6, 8, 23. (5) On *Rhus aromatica*. Ill.

Nabis ferus Linn. H.4. Au. 18, 19. (2) Ill.

Nabis elongatus, n. sp. H.6, Je. 9. (Note 9)

Sinea confusa Caud. Mol., S. 8. (2) Possibly *S. diadema*, as the males of these two species are not readily separable, and

no females were taken. The abdominal margin is nearly entire, scarcely undulate.

Acholla multispinosa DeG. H.2, Au. 18, 19. (2) Ill.

Zelus socius Uhl. H.1, 2, 3, 4, 6; Je. 8, 9, Au. 12, 15, 18, 19, 20, 22. (32) Common on *Rhus aromatica* in June and on *Mesadenia atriplicifolia* flowers in August. Seen eating *Phormia terrænovæ*. No other Illinois records.

Zelus renardi Kol. H.4, Je. 6. In black-jack. N. Ill. (Bolter Coll.).

Zelus luridus Stål. H.6, Je. 9. Ill.

Melanolestes picipes H.-Schf. Teheran, Au. 17, nymph. Under board by railroad. Ill.

Aradus acutus Say. H.1, Je. 7. Also from Cobden and Villa Ridge (S. Ill.)

Phymata fasciata Gray (*wolffi* Stål). H.2, Au. 13, 18. (10) Occasional on sand plants. Ill.

Emblethis griseus Wolff. H.2, 3; Au. 14, 19. (2) Ill.

Sphragisticus nebulosus Fall. Mol., S. 8. (2) Ill.

Ligyrocoris constrictus Say. H.1, Je. 7. Ill.

Ligyrocoris sylvestris Stål. Mol., S. 8. Ill.

Phlegyas annulicrus Stål. (Osborn, det.). H.4, Je. 5.

Blissus leucopterus Say. Teheran, Je. 22. Serious injury to corn on very sandy land. Ill.

Nysius angustatus Uhl. H.m. Ill.

Lygæus bicrucis Say. H.2, Au. 12, 13, 18. (18) Common on flowers of *Mesadenia atriplicifolia*. Ill. On *Mesadenia reniformis* at Carlinville (Rob.).

Lygæus turcicus Fabr. H.2, Au. 13. Ill.

Lygæus kalmii Stål. H.1, 2, 3, 5, 6, Teheran; Apr. 14, Je. 7, 8, Au. 13, 15, 17, 18. (17) On *Asclepias cornuti*. Ill.

Jalysus spinosus Say. H.m., July 12. Ill.

Serinetha trivittata Say. H.m., Je. 23, Au. 12. (12) On box-elder tree. Ill.

Stachyocnemis apicalis Dall. H.1, 2, 3, 5, Mol., Mer.; Je. 7, 8, 23, Au. 12, 14, 18, 22, 30. (69) In blowouts and on nearly bare sand. Excessively abundant at Devil's Hole one sunny day, but the next day, which was rainy, only one was found—under a cow-chip. Examples were seen apparently feeding on some bird droppings. No other Illinois records.

Alydus pilosulus H.-Schf. H.1, 2, Mol., Mer.; Je. 7, Au. 18, 30, S. 8. Nymphs, Au. 18. (21) Sandy ground among plants. On dry ground elsewhere in Illinois. The immature forms resemble ants.

Alydus conspersus Mont. Mol., S. 8. With the preceding species. Urbana.

Alydus eurinus Say. H.3, 4, 6, Mol.; Je. 5, 6, Au. 18, S. 8. Supposed nymph, Je. 6, 9. (7) With *A. pilosulus*. Ill.

Megalotomus 5-spinosus Say. H.1, 3, 4; Je. 6, 23, Au. 17, 20. (6) Ill.

Catorhintha mendica Stal (Osborn, det.). H.2, 3, 4, 5, 6; Je. 6, 8, 9, 12, 24, July 22, Au. 18. (26) Common on *Rhus aromatica*, *Allionia nyctaginea*, and a variety of other plants, especially along roadsides. Also from Camp Point (Adams Co.), Dixon, and Galena.

Chariesterus antennator Fabr. H.2, 3; Au. 12, 15. (3) On *Euphorbia corollata*. Tamaroa, Villa Ridge and Anna (S. Ill.).

Podisus maculiventris Say. H.5, Au. 17. Ill.

Perillus circumcinctus Stål. H.1, 2, 4; Je. 6, 8. Nymphs, Je. 5, 8, 23. (21) On *Rhus aromatica*, not uncommon. Makanda (S. Ill.), and "N. Ill."

Thyanta custator Fabr. H.2, Au. 18, 19. (2) Ill.

Cosmopepla carnifex Fabr. H.4, Je. 6. (33) On *Scrophularia nodosa* and other plants in black-jack, clustered along stems. Ill.

Neottiglossa sulcifrons Stâl. H. 4, Je. 6. (2) On vegetation of grassy open dunes. Dry hillsides in S. Ill.

Hymenarcys nervosa Say. H.4, Je. 6. Ill.

Cœnus delius Say. H.4, Je. 6. (3) Ill.

Euschistus fissilis Uhl. H.4, Je. 6. Ill.

Euschistus variolarius Pal. Beauv. H.2, 3, Mol.; Au. 14, 18, S. 8. (7) Ill. (Note 10)

Mormidea lugens Fabr. H.4, 5; Je. 5, 6, Au. 17. (4) Ill.

Pentatoma juniperina Linn. H.1, 2, 3, 4; Je. 6. Au. 13, 14, 18, 22. Nymphs, Je. 8 and in August. (35) Common on *Opuntia humifusa*, puncturing the tip of the fruit. Eureka and Mascoutah; Waukegan, on dwarf cedar (*Juniperus sabina*) along sand ridges near L. Michigan.

Peribalus limbolarius Stål. H.4, H.m.: Au. 20. (3) Ill.

Brochymena 4-pustulata Fabr. H.2, Je. 8. On trunks of elm along roadsides. Ill.

Sehirus cinctus Pal. Beauv. H.2, on *Monarda punctata*. Savanna and Galena (N. Ill.), on *Stachys* and sweet clover.

Pangæus bilineatus Say. H.2, Je. 8. Ill.

Cydnus obliquus Uhl. H.1, Au. 22. "N. Ill."

Cydnus, sp. (*Æthus*). H.2, Au. 19. (9) Nymphs under sticks in sandy hollow at lee of dune, under tree.

Homæmus æneifrons Say. H.4, Je. 6, Au. 20. (5) Swept from long grass on sand near black-jack. N. Ill. (Bolter Coll.); Lake Co., Ill., Au. 3. (Note 11)

Corimelæna ciliata Uhl. H.1, 2, 3; Je. 7, Au.12, 18. Very abundant in blow-sand about grass roots in June; also on plant stems in August. No other Illinois records.

NEUROPTERA.

Chrysopa plorabunda Fitch. H.2, Au. 18, 19. (3) Ill.

Chrysopa oculata Say. H.2, Au. 12, 13. (3) Ill.

Cryptoleon conspersum Ramb. H.4, Je. 5, 6. (4) Sand ridges near L. Michigan, Waukegan, Ill., Au. 22.

Cryptoleon signatum Hag. (Currie, det.). H.1, 2, 3, 4, H.m.; Je. 6, 7, 8, Au. 18, 19, 21, 22. (12) No other Illinois records.

Brachynemurus abdominalis Say (Adams, det.). H.m., August. Not rare in September. Ill.

Brachynemurus irregularis Currie (Currie, det.). H.m., Au. 21. No other Illinois record.

Myrmeleon immaculatus occidentalis Currie (Currie, det.). H.4, H.m.; Au. 20, 21. (4) No other Illinois records.

COLEOPTERA.

Cicindela scutellaris lecontei Hald. H.1, 3, 4, 6, H.m., Mol., Mer.; April, Je. 6, 23, Au. 18, 20, 22, 30, S. 4, 5, 6, 8. (58) Common on bare sand, especially in blowouts and roadways. Chicago; "N. Ill"; Peoria (Brendel); Fort Sheridan (Kwiat, '05); Waukegan.

Cicindela purpurea limbalis Klug. Mol., S. 8. Rock Island; "N. Ill."

Cicindela formosa generosa Dej. H.1, 2, 3, 4, 5, Mol., Mer., H.m.: Apr. 13, Je. 6, 7, 19, 23, 24, Au. 12, 13, 14, 17, 18, 20, 22, 29, 30, S. 4, 8. (45) Common with *C. scutellaris lecontei*. "N. Ill."; Peoria (Brendel).

Cicindela vulgaris Say. Mol., Mer.; Au. 30, S. 8. (3) Ill.

Cicindela repanda Dej. H.6, Mol., Mer., Thompson L.; Je. 8, 9, Au. 14, 29, S. 8. (68) Moist sandy shores: one example in blowout at Moline Sand Hill. Ill.

Cicindela 12-guttata Dej. Mol., S. 8. One example, taken in blowout at the Sand Hill. Ill.

Cicindela hirticollis Say. H.6, Je. 19. (2) Mud banks; sandy beach of L. Michigan, Waukegan. Ill.

Cicindela punctulata Fabr. H.1, 2, Matanzas L.; Je. 23, Au. 18, 22, 23. (6) Roadways and fields, if not very sandy; frequent Au. 24 on beach of L. Michigan at Waukegan, cast up by waves. Ill.

Cicindela cuprascens Lec. H.6, Mer.; Au. 10, 29. (4) Moist sandy margins of Illinois, Ohio, and Mississippi rivers, and L. Michigan, in Ill.

Cicindela lepida Dej. H.2, 3, Au. 14. In blowouts; not common. Savanna, on sandy island in Mississippi R.; N. Ill. (Bolter Coll).

Carabus sylvosus Say. H.2, Je. 8. (3) Under boards along lane in level ground. N. Ill. (Bolter Coll.); C. Ill.: Peoria (Brendel).

Calosoma externum Say. H.2, Je. 8. Ill.

Calosoma scrutator Fabr. H.m. (2) Ill.

Elaphrus ruscarius Say. H.6, Je. 8, 9. (2) Ill.

Pasimachus elongatus Lec. H.1, H.m., Teheran; Je. 7, Au. 17. (4) Ill.

Bembidium lævigatum Say. H.6, Je. 9. (3) Ill.

Patrobus longicornis Say. H.6, Mer.: Je. 8, 9, Au. 29, S. 5. (10) Ill.

Pterostichus sayi Brullé H.6, Je. 8. (3) Ill.

Pterostichus lucublandus Say. H.2, Je. 8. Ill.

Pterostichus caudicalis Say. H.6, H.m.; May 6, 15. (3) Ill.

Pterostichus erythropus Dej. H.6, Je. 9. Ill.

Amara cupreolata Putz. H.m., Apr. 13. Ill.

Loxandrus brevicollis Lec. H.6, May 6. "Ill."

Diplochila impressicollis Dej. H.m., April. Ill.

Platynus extensicollis Say. H.6, Je. 9. Ill.

Platynus decorus Say. H.6. Thompson L.: Feb. 26. May 6, S. 1. (4) Ill.

Platynus octopunctatus Fabr. H.6, Je. 8. (5) Ill.

Platynus placidus Say. H.6, Je. 12. Ill.

Zuphium longicolle Lec. H.m.

Tetragonoderus fasciatus Hald. H.5, 6; Je. 12, 22, July 22. (3) Dry sand of river banks. Grafton, Quincy, Savanna; Peoria (Brendel).

Lebia scapularis Dej. Matanzas L., Au. 23. Ill.

Callida purpurea Say. Teheran, Je. 22. Peoria (Brendel).

Chlænius erythropus Germ. H.6, H.m.; May 6, 21. (3) Ill.

Chlænius sericeus Forst. H.6, Thompson L.; May 6, Je. 8, 9, S. 1. (11) Moist shores, under driftwood. Ill.

Chlænius prasinus Dej. H.6, Matanzas L., Thompson L.; Je. 9, Au. 23, S. 1. (8) Ill.

Chlænius pennsylvanicus Say. H.6, H.m., Matanzas L., Thompson L.; Feb. 26, April, May 6, Au. 23, S. 1. (6) Ill.

Chlænius impunctifrons Say. H.6, May 6. Ill.

Anomoglossus emarginatus Say. H.6, S. 5. (2) Ill.

Oodes cupræus Chaud. H.6, Matanzas L., Thompson L.; Au. 6, 23, S. 21, 24. (10) Pekin and Carmi.

Geopinus incrassatus Dej. H.1, 6, H.m.; Apr. 13, Je. 7, 8, Au. 22. (10) Under sticks in blowout, and at electric lights. Ill. Seems to prefer sandy places.

Nothopus zabroides Lec. H.1, 2, 3, H.m.; Au. 14, 18, 19, 22, S. 16. (11) A common species under boards and logs on blow-sand and in blowouts. Many were seen in such situations at Devil's Neck June 7, but all were dead. Ill. (Bolter Coll.); C. Ill.; found also in the West on sandy stretches, *fide* Wickham (Wolcott).

Cratacanthus dubius Beauv. H.1, Au. 22. Common under sticks and boards in blowout at Devil's Neck. One found captured by a tiger-beetle, *Cicindela formosa generosa*. Ill.

Harpalus erraticus Say. Mol., S. 8. (11) Under sticks and cow-chips at edge of pasture on the Sand Hill, in company with another pallid species, *H. testaceus*. Illinois R. valley in La Salle Co.; Quincy. Inhabits sandy places.

Harpalus caliginosus Fabr. H.1, 3, 4, Mol.; Au. 14, 17, 20, 22. (12) Common under boards on sand. Ill.

Harpalus faunus Say. Mol., S. 8, Ill.

Harpalus herbivagus Say. H.1, Mol.; Je. 7, S. 8. (2) Ill.

Harpalus testaceus Lec. H.1, Mol.; Au. 22, S. 8. (2) Under boards

in blowout at Devil's Neck, also with *H. erraticus*. S. Ill. (Bolter Coll.); E. Cairo, Ky.; Quincy, September.

Stenolophus ochropezus Say. H. 6, Thompson L.; Apr. 14, Au. 14. (3) Ill.

Stenolophus dissimilis Dej. H.6, Feb. 26, S. 16. (4) Ill.

Anisodactylus rusticus Say. H.1, 2, Mol., H.m.; Apr. 13, Au. 18, 19, 20, S. 8. (17) Very common under boards and logs on sand, especially in blowout at Devil's Neck. Ill., generally distributed.

Anisodactylus carbonarius Say. H.4, Au. 20. Ill.

Anisodactylus discoideus Dej. H.6, Je. 8, 9. (11) A common river-shore species under driftwood on sand. Ill.

Anisodactylus baltimorensis Say. H.6, Je. 8. Ill.

Anisodactylus verticalis Lec. H.6, Je. 8. (2) Ill. (Bolter Coll.); Peoria (Brendel).

Anisodactylus piceus Lec. H.1, Au. 22. (6) Under boards in blowout at Devil's Neck. Ill.

Harpalini, n. sp. Mol., S. 8. With *Harpalus erraticus*. (Note 12)

Sphæridium scarabæoides Linn. Mol., S. 8. One specimen, with *Harpalus erraticus*. Introduced on Atlantic coast and spreading westward. Not previously reported west of the lake shore at Chicago. It was found there by me last spring also, Apr. 28, 1906, washed up by the waves in large numbers, about 80 specimens being taken. (See also Kwiat, '05.)

Cercyon analis Payk. H.6, Je. 7. Ill.

Silpha surinamensis Fabr. H.m., Je. 7. Ill.

Silpha inæqualis Fabr. H.6, Je. 8. (14) About carrion on sandy shore. Ill.

Silpha noveboracensis Forst. H.4, Je. 6. Ill.

Staphylinus maculosus Grav. H.6, Je. 8. Ill.

Staphylinus tomentosus Grav. H.6, May 6. Ill.

Bledius fumatus Lec. Mer., Au. 29. Ill., a common shore species.

Eustilbus apicalis Mels. H.6, Feb. 26. Ill.

Hippodamia glacialis Fabr. H.4, Au. 20. Ill.

Hippodamia convergens Guer. H.2, Au. 12. Ill.

Neoharmonia venusta Mels. H.6, July 8, on willow. Ill. (Bolter Coll.).

Coccinella 9-notata Hbst. H.2, 3, H.m.; Apr. 13, Au. 12, 18. (12) On sand plants. Ill.

Adalia bipunctata Linn. H.1, 6; Je. 8, 9, 23. (4) "Ill." (Bolter

Coll., one specimen); Jacksonville, from correspondent. Lately ('05, '06) seen occasionally about Urbana. Chicago ('06). No other Illinois records.

Hyperaspidius trimaculatus Linn.. H.4, Je. 6. No other Illinois record. (Note 13)

Languria bicolor Fabr. H.2, Je. 8. (10) On stems of *Mesadenia atriplicifolia*, in which the larvæ burrow. Also found thus at Champaign. "Ill."; Normal; Peoria (Brendel).

Ischyrus 4-punctatus Oliv. H.5, Je. 8, Ill.

Attagenus piceus Oliv. H.m., Je. 8. Ill.

Cryptorhopalum, sp. H.4, Je. 6. (3)

Hister interruptus Beauv. ·H.6, Je. 8. (2) Ill.

Hister abbreviatus Fabr. H.m. Ill.

Saprinus ferrugineus Mars. H.4, Je. 6. No other Illinois record.

Saprinus fraternus Lec. H.6, Je. 8, 9. (15) Abundant, feeding on dead fish along sandy shore. Ill.

Saprinus patruelis Lec. H.1, Je. 7. "N. Ill."

Tenebrioides mauritanica Linn. Teheran, Au. 17. In food stuffs.

Ptilodactyla serricollis Say. H.1, Je. 7. Ill.

Lacon rectangularis Say. H.1, 4; Je. 5. (7) Common under boards in dry sandy pasture. Grand Tower and Pekin, under boards along banks of Mississippi and Illinois rivers respectively. Peoria (Brendel).

Cardiophorus convexus Say. H.2, 4; Je. 5, 6, 8. (3) Ill. (Bolter Coll.).

Monocrepidius vespertinus Fabr. H.5, Teheran; Je. 16, 22, July 22. (9) Anna and Grand Tower (S. Ill.); Peoria (Brendel).

Melanotus communis Gyll. H.6, May 6 (larva). Ill.

Melanotus infaustus Lec.? H.1, 2; Je. 7, 8. (4) Ill.

Limonius quercinus Say. H.2, 4; Je. 6, 8. (43) Abundant on oak sprouts in grove at foot of sand ridge. Ill. (Bolter Coll.).

Chrysobothris femorata Fabr. H.m. Ill.

Acmæodera tubulus Fabr. H.1, H.m; Je. 23. (3) In flowers of *Opuntia* and *Chrysopsis*. "N. Ill.", Galesburg, Hudson, Cobden, Villa Ridge; Apr. 28, May 29, September; Peoria (Brendel); Carlinville, on *Hypoxys erecta* (Rob.).

Agrilus egenus Gory. H.1, Je. 7. (2) Ill.

Calopteron terminale Say. H.4, Au. 20. (4) With the next species. Ill. (Note 14)

Calopteron reticulatum Fabr. H.1, 2, 4, Mol.; Au. 19, 20, 22, S. 8. (20) Common on plants at sides of roadway through black-jack. Ill. (Note 14)

Lucidota atra Fabr. H.4, Je. 6. Ill.

Photuris pennsylvanica DeG. H.6, Je. 9. Ill.

Chauliognathus pennsylvanicus DeG. H.2, Au. 12. Ill.

Collops tricolor Say. H.1, 4, Je. 6, 23. (7) In *Opuntia* flowers. Peoria (Brendel).

Anthocomus erichsoni Lec. H.6, Je. 12. (2) Villa Ridge.

Anthocomus, sp. H.4, Je. 5.

Clerus thoracicus Oliv. H.4, Je. 6. Towanda, Villa Ridge, Peoria (Brendel).

Hydnocera subænea Spin. H.4, Je. 6. Ill. (Bolter Coll.).

Hydnocera pallipennis Say. H.5. Au. 12. "N. Ill.", Pekin.

Lucanus placidus Say. H.1, 4, 6; Je. 6, 7, 9. (7) Coming out of ground at dusk beneath shade trees along street of Forest City. Chicago; Peoria (Brendel). (Note 15)

Canthon nigricornis Say. H.1, Teheran; Je. 22, Au. 22. (3) Under dry animal remains in blowout at Devil's Neck. Peoria (Brendel).

Canthon lævis Drury. H.2, H.m.; Je. 7. (8) Common along roadways in level ground. Ill.

Copris carolina Linn. H.m. Ill.

Onthophagus hecate Panz. H.1, 4; Je. 6, 7. (2) Ill.

Onthophagus pennsylvanicus Harold. H.1, Je. 7. (9) Common about horse droppings in road near Devil's Neck. Ill.

Aphodius rubeolus Beauv. H.1, Je. 7. (2) With the preceding species. C. Ill.

Bolbocerus lazarus Fabr. H.m. Ill.

Trox scabrosus Beauv. H.1, Je. 7, Au. 22. With *Canthon nigricornis*. No other Illinois record.

Trox suberosus Fabr. H.m. Ill.

Lachnosterna prunina Lec. H.1, Je. 7. "N. Ill."; Peoria (Brendel).

Polyphylla hammondi Lec. H.5, Au. 17. Lying dead on bare blow-sand. No other Illinois record.

Anomala binotata Gyll. H.6, H.m.; Apr. 13, May 6, 21. (3) Ill.

Strigoderma arboricola Fabr. H.1, 2, 4; Je. 6, 7, 8, 23. (53) On flowers of clover, rose, *Opuntia humifusa*, and *Monarda punctata*. Ill.

Ligyrus gibbosus DeG. H.m., Apr. 13. Electric light. (2) Ill.

Ligyrus relictus Say. H.m., Je. 7. Electric light. Ill.

Euphoria sepulcralis Fabr. H.2, 3, Matanzas L.; Au. 14, 16, 18, 30. (7) In tops of various herbaceous plants. Common in southern Illinois.

Trichius piger Fabr. H.2, 4, 6; Je. 6, 8, 9. (3) On flowers of wild rose. Ill.

Parandra brunnea Fabr. H.2, H.m.; Au. 18. (3) Under log in grove at Devil's Hole. Ill., infesting the bases of fruit and shade trees.

Orthosoma brunneum Forst. H.m. Ill.

Physocnemum brevilineum Say. H.6, Je. 12. Ill.

Romaleum simplicicolle Hald. H.m. No other Illinois record.

Batyle suturalis Say. H.4, Au. 20. Ill.

Xylotrechus colonus Fabr. H.m. Ill.

Neoclytus erythrocephalus Fabr. H.4, Pekin; Je. 5, 6. (2) Ill.

Typocerus velutinus Oliv. H.6, Je. 9. On willow. Ill.

Typocerus sinuatus Newm. Teheran, Je. 22. Ill.

Mecas pergrata Say. H.1, 4; Je. 6, 23. (4) Dry soils of Illinoian glaciation in southern Illinois.

Oberea tripunctata Swed. H.2, Je. 8. Ill.

Tetraopes tetraophthalmus Forst. H.2, 4; Je. 6, 8, July 1. (3) On *Asclepias cornuti*. Ill.

Tetraopes femoratus Lec. H.3, Matanzas L., Mol.; Au. 15, 16, S. 9. (8) On *Asclepias*. Ill.

Lema cornuta Fabr. H.2, 3; Au. 18, 19. (11) On leaves of *Commelina virginica*, gnawing the surface and causing whitened streaks. Richardson ('92) describes a similar injury to this plant by *L. sayi*. He found its eggs placed singly in the folds of the central leaf about the flower stalk, and the larvæ,—which were white, with a black spot on the second segment,—eating down an inch or two into the soft stalk. Knaus ('01) found *L. cornuta* feeding on dock near sand-hills in Kansas. Sand-dunes of N. W. Ind. (Kwiat '05).

Cryptocephalus 4-maculatus Say. H.6, Je. 9. Ill.

Cryptocephalus mutabilis Mels. H.4, Au. 20. Ill.

Pachybrachys pubescens Oliv. Teheran, Je. 22. Ill.

Monachus ater Hald. H.4, Je. 6. (2) Ill.

Monachus saponatus Fabr. H.4, Je. 6. (3) Ill.

Graphops nebulosus Lec. H.4, Je. 6. (2) Ill.

Typophorus aterrimus Oliv. H.4, Je. 6. Ill.

Metachroma angustulum Cr. H.2, 4, 6; Je. 5, 6, 8, 9. (21) Abundant on Carolina poplar, willow, *Œnothera biennis*, and other plants, on sand-dunes and along the river shore. No other Illinois records.

Metachroma parallelum Horn. H.1, 2, 4, 6; Je. 6, 7, 8, 9. (30) Very abundant on willow, *Œnothera biennis*, and other plants, in company with the preceding species. Peoria (Brendel).

Leptinotarsa 10-lineata Say. H.2, Au. 19. Ill.

Zygogramma suturalis casta Rog. H.2, 4; Je. 5, Au. 18, 19. (4) Ill.

Chrysomela auripennis Say. H.1, H.m.; Je. 7, S. 29. (2) Normal, Galesburg, and Waterman, May, Je. 14, and August; "N. Ill."; Ill. (Bolter Coll.). Sand-dunes of N. W. Ind. (Kwiat '05).

Melasoma lapponica Linn. H.1, 6; May 21, Je. 7, 8, 9. (14) On willows in sand-dune hollows and along river shore. Ill.

Melasoma scripta Fabr. H.6, Je. 8, S. 4. (4) On willows along river shore. Ill.

Cerotoma trifurcata Forst. H.4, Je. 6. (4) Ill.

Diabrotica 12-punctata Oliv. H.2, Je. 8, Au. 12, 13, 18, 19. (5) Ill.

Diabrotica longicornis Say. H.2, Teheran; Au. 17, 18. (4) Ill.

Galerucella notulata Fabr. H.4, Je. 6, Au. 20. (3) Ill.

Blepharida rhois Forst. H.1, 2, 4; Je. 5, 6, 8, 23. (52) Larvæ, Je. 5. Common on *Rhus aromatica*, sometimes defoliating it. Ill.

Œdionychis vians Ill. H.6, Je. 9. Ill.

Œdionychis thyamoides Cr. H.4, Je. 6. (2) Ill.

Disonycha pennsylvanica Ill. H.1, 4, 6; May 6, Je. 6, 7, 8, 9. (6) On willow. Ill.

Disonycha 5-vittata Say. H.1, Je. 7, Au. 22. (3) On willow in dune hollows. Same situation, Waukegan, near L. Michigan. Ill.

Disonycha triangularis Say. H.6, Je. 8. Ill.

Haltica fuscoænea Mels. H.2, 4, 5; Je.6, 8, July 22, Au. 12. (14) On *Œnothera biennis*, its food plant. No other Illinois records.

Systena blanda Mels. H.4, Je. 6. (4) Ill.

Chalepus smithi H. Donck. (*Odontota horni*). H.4, Au. 20. No

other Illinois record. N. W. Ind., coll. by Wolcott (see Kwiat '05).

Chalepus dorsalis Thunb. (*Odontota*). H.1, Je. 7. (3) Ill.

Coptocycla clavata Fabr. H.1, Je. 7. Bloomington and Kappa, Mar. 8, July 14; N. Ill. (Bolter Coll.); Peoria (Brendel).

Bruchus cruentatus Horn. H.2, Au. 18. (8) On *Cassia chamæcrista*, probably breeding in the seeds. Ill.

Bruchus hibisci Oliv. H.4, Je. 6. (2) Camp Point and Normal, Ill.

Zabrotes, n. sp. H.2, Au. 18.

Epitragus acutus Lec. H.1, 2, 3, 4, 5, 6, H.m.; July 22, 30, Au. 3, 12, 14, 18, 19, 20, 22. (23) On flowers of *Mesadenia atriplicifolia*. No other Illinois records.

Scotobates calcaratus Fabr. H.1, Je. 7. Ill.

Xylopinus saperdioides Oliv. H.1, Je. 7. Ill.

Tenebrio molitor Linn. H.m. (2) Ill.

Opatrinus notus Say. H.1, Je. 7, 8, Au. 22. (21) Common under boards in dry sandy pasture in company with *Lacon rectangularis*. On sandy land in Texas (Hart, '06) the same association is conspicuous, except that *O. notus* is replaced by the allied species *aciculatus*. Ill.

Blapstinus interruptus Say. H.6, Je. 8, 9, 12. (4) In dry bare sand along upper slope of river bank. Ill. (Bolter Coll.). Collected by Wolcott in "Chicago Area" (Kwiat '05). On sand near Waukegan, Au. 18.

Hymenorus obscurus Say. H.1, Je. 7. Ill.

Nothus varians Lec. H.4, Je. 5. (3) Ill. (Lec.).

Mordella scutellaris Fabr. Teheran, Je. 22. Ill.

Mordella octopunctata Fabr. H.6, Je. 9. Ill.

Mordella marginata Mels. H.4, H.m.; Je. 5, 6, July 12. (5) Ill.

Mordellistena biplagiata Helm. H.2, 4; Je. 5, 8. (2) "N. Ill., June"; Carlinville (Rob.).

Stereopalpus mellyi Laf. H.1, Je. 7. (3) Rock Island; sand ridges near Waukegan, Au. 23.

Notoxus bifasciatus Lec. Teheran, Je. 22. Ill.

Macrobasis unicolor Kirby. H.1, 2, Mer.; Je. 8, 23, Au. 30. On *Cracca virginiana*. (18) Ill.

Epicauta pennsylvanica DeG. H.1, 2, 4; Je. 6, 7, 8. (7) Ill.

Rhipiphorus pectinatus Fabr. H.2, Au. 18, 19. (2) On plants on dune slopes. Ill.

Attelabus bipustulatus Fabr. H.2, Je. 8. On *Œnothera biennis* stems on sand-dunes. Villa Ridge, September; Peoria (Brendel).

Phacepholis candida Horn. H.1, 2, 4; Je. 6, 7, 8. (22) Abundant on stems of plants along the railroad in low ground near Forest City. Urbana. (Note 16)

Phytonomus comptus Say. H.6, Je. 8. (5) Ill.

Lixus concavus Say. H.2, Je. 8. Ill.

Magdalis armicollis Say. H.2, 6; Je. 8, 12. (3) On elm along roadside. Ill.

Rhyssematus lineaticollis Say. H.3, Au. 15. On *Asclepias cornuti.* Morris, July 19; "N. Ill."

Chalcodermus collaris Horn. H.2, Je. 8, Au. 12. (14) Common on *Œnothera biennis* on dune slopes. Knaus ('93) found "a fine lot" about Kansas sand-dunes, which he thought bred in the seed pods of the *Yucca* which was abundant along the sides of the blowouts. There is no wild *Yucca* in this valley. Chittenden thinks its habits are probably similar to those of *C. æneus*, which breeds in cow-peas. No other Illinois records.

Tyloderma foveolatum Say. H.6, Je. 8. On stems of *Œnothera biennis*, in which the larvæ breed. Ill.

Acanthoscelis acephalus Say. H.2, Je. 8. Ill. (Bolter Coll.); Peoria (Brendel). Occurs on *Œnothera biennis.*

Trichobaris trinotata Say. H.4, Je. 5. Ill.

Centrinus picumnus Hbst. H.4, Je. 6. Ill.

Rhodobænus 13-punctatus Ill. H.2, Je. 8. Ill., on cocklebur.

Lepidoptera.

Pyrameis huntera Fabr. H.2, Au. 12, roadside. Ill.

Apatura celtis Boisd. & Lec. H.2, Au. 18, roadside. Ill.

Apatura clyton proserpina Scudd. H.2, Au. 18, roadside. Ill.

Thecla melinus Hübn. H.2, Au. 13, roadside. Ill.

Chrysophanus hypophlæas Boisd. H.2, Au. 13, roadside. Ill.

Pieris protodice Boisd. & Lec. H.2, Au. 13, roadside. Ill.

Colias philodice Godt. H.3, Au. 18. Ill.

Terias lisa Boisd. H.2, 3; Au. 13, 14. (2) Ill.

Pamphila zabulon Boisd. & Lec. H.3, Au. 17. Ill.

Pamphila metacomet Harr. H.2, Au. 13. Ill.

Pyrgus tessellata Scudd. (Skinner, Ent. News, Vol. XVII., p. 277.) H.3, Au. 17. Common along roadways in sand region. Ill.

Eudamus tityrus Fabr. H.2, Au. 18, roadside. Ill.

Eubaphe aurantiaca brevicornis Walk. H.2, Je. 8. (2) Frequent on sand-dunes. Ill.

Estigmene acræa Drury. H.3, Au. 17. Ill.

Chloridea virescens Fabr. H.1, 6; Je. 8, Au. 11. Urbana; Ill. (Bolter Coll.).

Heliocheilus paradoxus Grote. H.2, 5; Je. 17, Au. 12, 13. (2+) These curious little noctuids dance up and down in stationary groups of usually two to four at twilight, in open sandy ground, near the level of the tops of plants. The subcostal and discal cells of the male fore wings are greatly enlarged, transversely ribbed, and usually denuded. While they are dancing, a continuous rapid series of sharp ticks is heard, exactly like that of a watchman's rattle, but of diminutive volume, yet easily heard fifty feet away. This is probably effected by the male's extending the fore legs and rasping the tibial spurs against the corrugated cell-membranes during flight. Urbana, Au. 28 and S. 29, in gravel-cut on railroad.

Schinia arcifera Guen. H.2, Au. 13. Ill.

Xanthoptera semiflava Guen. (Dyar, det.). H.3, Au. 17. Ill.

Acontia lactipennis Harvey. H.1, 4; Je. 6, 7. (2) This handsome Texan species is new to Illinois.

Ypsia undularis Drury. H.1, Je. 23. Ill.

Sesia tipuliformis Linn. (Dyar, det.). H.2, Au. 13. Ill.

Meroptera cviatella Dyar (Dyar, det.). H.4, Je. 5. Recently described (Proc. Ent. Soc. Wash., Vol. VII., p. 34) from Chicago, and named after the collector, Mr. A. Kwiat. This may be a sand-region species, common to the Lake Michigan and Illinois valley areas.

Crambus haytiellus Zinck. (Dyar, det.). H.2, Au. 12. Not infrequent about sand blowouts. Described from Hayti and listed from Texas. No other records found.

Olethreutes dimidiana Sodoff? (U. S. Bur. Ent., det.). H.1, 2; Je. 7, 8 (all immature). In these two localities many cylindrical tubes of webbed sand were found extending up the stems of *Onagra biennis*, *Cassia chamæcrista*, and *Ambrosia*(?), often as much as two feet long, and following most of the stems of a plant, reaching the top, where the new growth had been fed upon. In one case a short tube was formed on the surface of the bare sand. These tubes closely resemble those figured

by Daecke ('05) for *Prionapteryx nebulifera*, from sand areas in New Jersey. In these tubes were found small and very active tortriciform larvæ. Mr. J. J. Davis, of the University of Illinois, submitted an example to Mr. Daecke, who replied that it was not the same as his species. Mr. Davis was successful in securing an adult from these larvæ June 30, and the Bureau of Entomology at Washington has determined it for him as *Olethreutes dimidiana*, a European species, reported also from Missouri. The larva of this species, however, according to Treitschke, is quite differently marked from our specimens, feeds on birch and elder, and occurs in August instead of June, pupating in September and emerging the following May.

Diptera.

Tipula, sp. H.6, S. 4.

Spogostylum albofasciatum Macq. H.3, Au. 18. No other Illinois record.

Exoprosopa fasciata Macq. H.1, 2, 4, 5; Au. 12, 17, 18, 20, 22. (9) Ill.

Exoprosopa fascipennis Say. H.3, Teheran; Au. 14, 17. (2) Ill.

Anthrax lateralis Say. From a pupa apparently of the ordinary noctuid type, taken by Mr. Davis at the Devil's Hole June 8, an adult of this species emerged July 1. The species of this genus rest quietly—making occasional short flights—about roadways and bare sandy places. Ill.

Anthrax hypomelas Macq. H.6, S. 5. This species has been bred from cutworms (Ins. Life, Vol. II. p. 353). No other Illinois record.

Anthrax halcyon Say. H.6, S. 4. Savanna, July 22; Carlinville (Rob.).

Anthrax fulvohirta Wied. H.2, 3; Au. 12, 18. (2) Ill.

Anthrax sinuosa Wied. H.6, Je. 9. Matteson, July 8; Carlinville, on *Psoralea onobrychis* (Rob.).

Systœchus vulgaris Loew. H.1, 2, 3; Au. 18, 22. (5) On flowers. Ill.

Phthiria sulphurea Loew. H.2, 4; Au. 18, 20. (2) Roadside plants. Cockerell has noted it resting on composite flowers of the same color as itself. Ill.

Psilocephala pictipennis Wied. H.4, 6; Je. 6, 9. (2) No other Illinois records.

Psilocephala hæmorrhoidalis Macq. H.2, 4; Je. 6, Au. 18. (2) Resting on bare sand. Ill.

Laphystia 6-fasciata Say. H.2, 4; Je. 6, 7. (2) On the bottoms of deep blowouts in company with *Microbembex monodonta*, which it somewhat resembles, especially when in action. No other Illinois records. Common at the seashore. (Note 17)

Dasyllis grossa Fabr. H.4, July 1. No other Illinois record.

Proctacanthus brevipennis Wied. H.1, 2, 4; Je. 6, 7, 8, 23. (6) Flying about vegetation in sandy places, and alighting on or near the ground. No other Illinois records. These "robber-flies" prey on other insects.

Proctacanthus milbertii Macq. H.2, 3, 4; Au. 15, 18, 19, 20. (9) With the preceding species; said to prey upon honey-bees and grasshoppers. Sand ridges near L. Michigan, Waukegan. *Asilus agrion* Jaennicke, a doubtful synonym, is the only other record for Illinois.

Erax æstuans Linn. H.1, 4; Je. 6, 7. (8) Common along sandy roads near the Devil's Neck. La Salle Co., Mt. Carmel, Urbana, sand at Waukegan; Au. 16, 28, S. 25.

Promachus vertebratus Say. H.1, Au. 22. Ill. A common robber-fly.

Asilus angustifrons Will. (Coquillett, det.). H.6, Je. 9. No other Illinois record.

Rhadiurgus leucopogon Will. (Coquillett, det.). H.2, 3; Au. 12, 17, 18. (8) This robber-fly is common at Devil's Hole. No other Illinois records.

Mesogramma politus Say. H.2, Au. 19. Ill.

Mesogramma marginata Say. H.2, Au. 19. Ill.

Volucella fasciata Macq. H.1, 2, 3, 4; Je. 6, 8, 23, Au. 12, 13, 14, 17, 18, 19. (14) This odd little syrphid is one of the characteristic blow-sand species. The larvæ breed in the tissues of the cactus (*Opuntia humifusa*) which grows abundantly in this region (Smith, '91, Williston, '91). The adults are often seen flying about, and abound on roadside flowers, such as *Verbena*, dandelion, sweet clover, etc. No other Illinois records.

Conops sylvosus Will. H.3, Au. 14. No other Illinois record.

Conops xanthopareus Will. H.1, 2, 4; Je. 6, 7, Au. 18. (4) Ill.

Zodion obliquefasciatum Macq. (*leucostoma* Will.). H.2, 6, Pekin; Au. 12, 18. (3) Urbana and Sandwich; July 25 and 28. Carlinville (Rob.).

Cistogaster immaculata Macq. H.2, Je 8. Ill.

Ocyptera carolinæ Desv. H.2, 4; Je. 6, 8. (3) Ill.

Sturmia albifrons Walk. (Coquillett, det.). H.2, Au. 19. (2) Ill.

Phormia terrænovæ Desv. (Coquillett, det.). H.2, Au. 18, 19. (4) Very common on *Cassia chamæcrista* at Devil's Hole. A common species of house-fly.

Musca domestica Linn. H.2, Au. 18. Not infrequent at Devil's Hole. The common house-fly.

Anthomyia pratincola Panz. (Coquillett, det.). H.2, Au. 18. No other Illinois record.

Cœnosia lata Walk. (Coquillett, det.). H.2, Au. 19. No other Illinois record.

Rivellia viridulans Desv. H.4, Je. 6. (2) Ill.

Rivellia 4-fasciata Macq. H.2, 6; Je. 9, Au. 19. (3) Common on plants along the river shore. Ill.

HYMENOPTERA.

Tenthredo verticalis Say. H.4, Je. 6. Ill. (Bolter Coll.).

Dolerus arvensis Say. H.5, Apr. 14. Ill.

Monophadnoides rubi Harr. H.2, Je. 8 (larvæ). On raspberry by roadside. Ill.

Schizocerus, n. sp. (Ashmead, det.). H.3, Au. 14. Common on undetermined low plants at edge of blowout, associated with *Chelonus*, and closely imitated by it. (See *Chelonus texanus*, below.)

Iphiaulax eurygaster Brullé. H.4, Au. 20. Ill.

Cardiochiles apicalis Cress. (Ashmead, det.). H.2, Au. 18. (5) Ill.

Microdus sanctus Say (Ashmead, det.). H.4, Je. 6. (2) Ill.

Chelonus texanus Cress. (Ashmead, det.). H.3, Au. 14. Examples of *Chelonus* were very abundant in association with an undescribed *Schizocerus*, so closely resembling it when in action that the two were hard to distinguish. Two *Chelonus* were taken, and proved to be one each of this and the next species. No other Illinois record.

Chelonus angheri La Mun. (*Ascogaster*) (Ashmead, det.). H.3, Au. 14. (See the preceding species.) No other Illinois record.

Exochilum fuscipenne Nort. (Ashmead, det.). H.2, 5; Au. 12, 13. (2) Ill.

Nototrachys canadensis Prov. (Ashmead, det.). H.2, Au. 19. Ill.

Enicospilus purgatus Say. H.1, 6; Au. 22, S. 4. (5) Ill.

Lampronotus mellipes Prov.? ("*mellipes* Say"; Ashmead, det.). H.6, Je. 9. No other Illinois record known to me.

Amblyteles nubivagus Cress. H.5, 6; Je. 9. (2) Ill.

Ichneumon subcyaneus Cress. H.m., Au. 19. Ill.

Formica fusca Linn. H.2, Au. 19. Ill.

Formica pallidefulva schaufussi Mayr. H.2, Au. 18, 19. (5) Very few ants' nests were seen in the blow-sand. Ill.

Lasius niger americanus Linn. Mol., S. 8. Males and females swarming from a large nest in the coarse grass on the slope of the Sand Hill. Ill.

Lasius latipes Walsh. Mol., S. 8. (2) Examples under boards at edge of pasture on the Sand Hill, along with the pallid harpaline beetles. Rock Island (Walsh); Muncie.

Prenolepis fulva Mayr? H.5, Au. 17. (7) Nesting in sand in a thicket. Ill.

Camponotus herculaneus Linn. H.5, Au. 17. In same place as preceding species. Ill.

Myrmica rubra scabrinodis schencki Emery. H.5, Au. 17. (3) In thicket with the two preceding species. Ill.

Pheidole vinelandica Forel (Ashmead, det.). H.5. A sand-inhabiting species. No other Illinois record.

Monomorium minutum Mayr (Ashmead, det.). H.2, Au. 18. Ill.

Sphærophthalma, n. sp. (Melander, det.). Mol., S. 8. (2) Belongs to *simillima* group.

Sphærophthalma harmonia Fox (Melander, det.). H.2, 3; Au. 14, 18. (13) One of the commoner species of the Illinois valley blow-sand areas. Sand-dunes in N. W. Ind. (Melander, '03); Pine Hills, Union Co. (S. Ill.), Au. 11.

Sphærophthalma occidentalis Linn. H.2, 3, Mer., Pekin; Au. 12, 13, 14, 17, 29. (6) Occasional. The Mason Co. examples are all a golden ochre color. The Meredosia specimen is of the usual scarlet color of the species, as are also the State Laboratory specimens, which are all from southern Illinois. Mason Co. is near the northern limit of its range.

Sphærophthalma 4-guttata Say. H.2, 3, Mol.; Au. 12, 14, 18, S. 8. (7) Savanna, Normal, and Metropolis; July 25, 26, Au. 18, September.

Sphærophthalma ferrugata Fabr. (Melander, det.). H.1, 2, 3, 4, 5, Mol.; Au. 14, 17, 18, 20, 22, S. 8. (15) Another common species of our sand regions.

Sphærophthalma vesta Cress. (Melander, det.). H.4, Au. 20. No other Illinois record.

Sphærophthalma canella Blake (*rugulosa* Fox) (Melander, det.). Mol., S. 8. No other Illinois record.

Sphærophthalma chlamydata Mel. H.1, 2, 3, 4, 6, H.m., Mer.; Je. 23, Au. 12, 14, 15, 18, 29, S. 5. (80) H.3 (Melander, '03, *chlamydata*). The leading species of velvet ant in the Illinois-valley sand area. It will be noted that with the exception of a single *Methoca bicolor* no *Mutillidæ* whatever were seen during the early June visit to the Illinois valley region. (Note 18)

Sphærophthalma agenor Fox (Melander, det.). H.2, 4, Mol.; Au. 18, 20, S. 8. (7) Ill.

Sphærophthalma macra Cress. H.2, Au. 18. Ill. (Note 19)

Timulla hexagona Say. H.2, 6; Au. 18, S. 5. (3 males) Ill.

Timulla dubitata Smith. H.1, 3 (Melander, '03), 4; Au. 20, 22. (4 females) Ill. Probably female of *hexagona*.

Methoca bicolor Say (Ashmead, det.). H.6, Je. 9; the only mutillid taken in early June. Lake Co. Ill., in gravel-pit (Melander, '03).

Tiphia punctata Rob. H.2, 3; Au. 13, 14, 18. (9) Ill.

Dielis plumipes Drury. H 2, 4, 6, Pekin; Je. 6, 8, Au. 15. (54 males, 2 females) Abundant on dandelion and sweet clover flowers along roadsides at Forest City and the Devil's Hole in June. N. Ill. (Bolter Coll.); Rock Island, Savanna, Fox L.; July 26, 30. Carlinville (Rob.).

Trielis octomaculata Say. H.3, Au. 14. The thorax of this example is black except for three very small yellowish dots on the collar. No other Illinois record.

Discolia bicincta Fabr. H.5, Au. 17. Ill.

Plesia namea Fabr. (*Myzine*) (Ashmead, det.). H.2, Au. 18. (2) Common on flowers of *Mesadenia atriplicifolia*. Ill.

Plesia interrupta Say. H.2, 3, H.m., Teheran; Au. 12, 13, 14, 17, 18, S. 25. (10) Ill.

Plesia, sp. (Ashmead, det.). H.2, H.m.; July 1, Au. 18, S. 25. (4)

Plesia obscura Fabr. (Ashmead, det.). H.2, 3, 6, H.m.; July 29, Au. 12, 14, S. 10. (5)

Hedychrum obsoletum Say. H.1, 2; Au. 12, 22. (2) Ill.

Ancistrocerus campestris Sauss. H.4, Au. 20. Ill.

Odynerus pedestris Sauss. H.2, Au. 18. Ill.

Odynerus geminatus Cress. (Ashmead, det.). H.2, Au, 18. (2) No other Illinois record.

Odynerus dorsalis Fabr. H.2, Au. 13, 19. (2) Ill.

Polistes pallipes St. Farg. H.2, 4; Au. 12, 18, 20. (6) Common on *Cassia chamæcrista*.

Vespa cuneata Fabr. H.2, 4, Mer.; Je. 6, 8, Au 30. (11) On fresh watermelon rinds in sandy road. Abundant at Du Bois about cider-mill August 24; Normal, July 28; Aldridge, Au. 11; Carlinville, on *Aster ericoides villosus* (Rob.).

Vespa germanica Fabr. H.4, Je. 6, Au. 20. (8) Ill.

Ceropales fulvipes Cress. H.2, Au. 18. Ill.

Anoplius ingenuus Cress. (*Pompilus*). H.1, 4; Je. 7, Au. 20. (2) Ill.

Anoplius scelestus Cress. H.2, 4; Au. 12, 20. (2) Ill.

Anoplius atrox Dahlb. H.2, Au. 12. Ill.

Anoplius philadelphicus St. Farg. H.6, Au. 30. Ill.

Anoplius tropicus Linn. H.1, 2, 3; Je. 7, Au. 17, 18, 19. (5) Ill.

Anoplius fuscipennis St. Farg. H.2, 4; Au. 12, 20. (2) Ill.

Anoplius marginatus Say. H.2, Au. 12, 18. (3) Ill.

Anoplius cylindricus Cress. H.m. Ill.

Anoplius biguttatus Fabr. H.2, 6; May 20, Au. 12, 18. (2) Ill.

Anoplius, spp. (Ashmead, det. "*Ceropalidæ*; can not be determined at present"). H.1, 2, 3, 4; Au. 14, 18, 20, 22. (9) Four species.

Cryptocheilus nebulosus Dahlb. (*Priocnemis*). H.6, Au. 12.

Cryptocheilus, sp. H.2, Au. 13.

Ammophila vulgaris Cress. H.2, Au. 18. (5) Ill.

Ammophila argentata, n.sp. H.1, 2; Je. 7, Au. 18, 22. (3) (Note 20)

Ammophila procera Klug. H.2, 3, 4; Je. 6, 8, Au. 13, 14, 18, 19. (5) Ill.

Ammophila extremitata Cress. (*pictipennis* Walsh). H.2, Au. 13. Ill.

Priononyx bifoveolatus Tasch. (*thomæ* Fabr.). H.2, Au. 19. Ill.

Priononyx atratus St. Farg. H.2, Au. 18. Ill.

Sphex pennsylvanicus Linn. H.1, Au. 22. Ill.

Sphex ichneumoneus Linn. H.1, 2; Au. 18, 22. (2) Ill.

Anthophilus pulchellus Cress. H.2, Au. 18. (3)

Cerceris fumipennis Say (Ashmead, det.). H.4, Au. 20. Ill.

Cerceris venator Cress. (Ashmead, det.). H.2, Au. 12, 18. (2) Ill.

Tachysphex texanus Cress. (Ashmead, det.). H.2, Je. 8. No other Illinois record.

Tachytes obscurus Cress. H.2, Au. 13. Ill.

Stictia carolina Fabr. (*Monedula*). H.2, 5; Au. 12, 18. (2) N. Ill. (Bolter Coll.); Carlinville, on *Pycnanthemum muticum pilosum* (Rob.).

Microbembex monodonta Say. H.2, 3; Au. 12, 14, 18. (8) Resting on bare sand in blowouts, or flying about near the surface. Ill.

Bembex spinolæ St. Farg. H.3, 6, Mol.; Au. 14, 18, S. 8. (4) Common along the sandy shore above Havana. Ill.

Bembidula capnoptera Handl. H.2, Au. 13. No other Illinois record. (Note 21)

Bembidula 4-fasciata Say. H.4, Au. 20. Carlinville, on *Pycnanthemum linifolium* (Rob.).

Mimesa argentifrons Cress. Mol., S. 8. Ill.

Anacrabro ocellatus Pack. H.2, 4; Au. 18, 20. (3) Ill.

Notoglossa americana Rob. H.2, 4; Je. 6, Au. 18. (2) Ill.

Colletes americana Cress. H.2, 3; Au. 12, 14, 18. (5) Carlinville, on various flowers (Rob.).

Colletes latitarsis Rob. H.1, 3; Au. 12, 21. (3) Ill.

Chloralictus pilosus Smith. H.1, 2, 3; Au. 14, 18, 22. (4) Ill.

Lasioglossum coriaceum Smith. H.4, Au. 20. Ill.

Oxystoglossa confusa Rob. H.5, Au. 12. Ill.

Augochlora fervida Smith. H.2, Au. 12. Ill.

Augochlora humeralis Patton (Titus, det.). H.2, 3; Je. 8, Au. 14, 18, 19. (5) Ill.

Agapostemon texanus Cress. H.2, Au. 18. Ill.

Agapostemon splendens Lep. H.1, 2, 4, 6; Je. 6, 7, 8, 9, Au. 18. (7) On sweet clover.

Halictus tumulorum Linn. H.4, Je. 6. Ill.

Cœlioxys octodentata Say. H.2, 5; Je. 8, Au. 13, 17, 18, 19. (7) Ill.

Megachile mendica Cress. H.3, 4; Au. 15, 20. (3) Ill.

Megachile brevis Say. H.2, 3, 4; Au. 15, 18, 20. (6) Ill.

Megachile latimanus Say (Titus, det.). H.2, Au. 13, 19. (27) Found one cloudy morning (Aug. 13) resting in occasional large clusters on dead wild verbena stems along the road to Devil's Hole.

Nothosmia albiventris Cress. H.4, Je. 6. Ill.

Epeolus concolor Rob. H.2, 6; July 22, Au. 13, 19. All Ill.

Epeolus lunatus Say. H.1, 2, 4; Au. 13, 18, 19, 20, 22. (18) On the occasion referred to under *Megachile latimanus*, *E. lunatus* was frequently found singly, attached by its jaws to various plants. No other Illinois records.

Epeolus bifasciatus Cress. (*fumipennis*). H.1, Au. 22. Ill.

Epeolus pusillus Cress. H.2, Au. 18. Carlinville, on *Compositæ* (Rob.).

Melissodes obliqua Say (Titus, det.). H.2, Au. 13, 18, 19. (10) Ill.

Melissodes atripes Cress. (Ashmead, det.). H.2, 3; Au. 13, 14, 17, 18, 19. (38) On the occasion referred to under *Megachile latimanus* this species also was found in large numbers, clustered on dead weed stems by the roadside.

Melissodes agilis aurigenia Cress. H.1, Au. 22. Ill.

Tetralonia dilecta Cress. H.2, 4; Je. 6, 8. (2) Ill.

Bombus pennsylvanicus DeG. H.2, Au. 12, 18. (2)

Bombus vagans Smith. H.4, Matanzas L.; Je. 6, Au. 15. (3) Ill.

Bombus virginicus Oliv. H.2, 3; Au. 17, 18. (3) Ill.

Bombus separatus Cress. H.2, Au. 13. Ill.

Apis mellifera Linn. H.1, 2, 3; Je. 7, Au. 13, 14, 18. (6) Common on flowers of *Monarda punctata* and other plants in the sand region.

BATRACHIA.

Hyla squirella Bosc. H.1. Two seen on bushes on open sand-dune.

REPTILIA.

Heterodon simus Linn. Pekin (H. Garman, '92). The hog-nose snake is common in the Illinois valley sand region, particularly under boards along sandy roads at the Devil's Neck, and under stones and driftwood along the sandy shores.

Cnemidophorus sexlineatus Linn. H.1, Je. 7. Henry, in a dry sunny field on the banks of the Illinois River, not rare; Ottawa; lives in dry sandy regions (H. Garman, '92).

Terrapene carolina Linn. (*Cistudo*). About ten years ago I saw a number of these box-turtles traveling about the dunes of the Devil's Hole, but only one was seen by us during the field work for this article. The sinuous line at the edge of a moving dune, shown in Pl. XII., Fig. 2, was probably made by this box-turtle. Southern Illinois, dry woods (H. Garman, '92).

Mecostethus platypterus Scudd. (Page 231) While this article is going through the press I find Mr. E. D. Ball's list of Iowa *Orthoptera* ('97), supplementary to that of Osborn, in which he records this species from the extreme northwestern corner of that state. Otherwise it is known only from New England, and is only so listed by Scudder in his Catalogue ('00). Mr. Ball also records *Mermiria bivittata* from Iowa, which is a little north of its usual range.

Arphia xanthoptera Germ. (Page 232) On page 214, in discussing the differences of hind-wing coloration of certain *Orthoptera* in dry and humid environments, I mention the lack of sufficient material for a comparison of the two variably colored species which are common both in the sand region and on the humid prairie. An opportunity for such a comparison has since been afforded by the kindness of Mr. J. D. Hood, of the University of Illinois. Mr. Hood is making a very interesting study of a similar sand region in Wisconsin, and has secured a large series of *Arphia xanthoptera*, which may properly be compared with our series from the humid prairie, as the effect of aridity would be reduced rather than increased by the higher latitude of his locality. Blatchley says that in Indiana one third or more of the males have yellow wings and not over one sixth of the females, or an average of one fourth. Our collections show practically identical conditions, the usual color being a clear orange-red. On the other hand, Mr. Hood states that although in the Wisconsin sand region this species was very abundant, being seen by the hundreds every day, only a single orange-winged specimen was observed during five weeks' collecting, all the rest having yellow wings with at most a faint tinge of orange. Mr. Hood pertinently points out that the original color in all these species is probably that found in the more arid environment; not the reverse, as might be inferred from my wording.

Lepyronia gibbosa Ball? (immature). In the preceding list (page 236) I have mentioned immature *Cercopidæ*, probably *L. gibbosa*, occurring on the extreme bases of the stems in tufts of *Callirhoe triangulata*. Ball ('01) has found a western *Aphrophora* feeding on pine in the adult stage, but in the immature

stages inhabiting the stem bases of *Chrysopsis villosa* and *Lupinus* sp. after the manner of our species on *Callirhoe*. He regards this as a result of the arid environment, the enveloping froth with which the young surround themselves being more easily maintained here than on exposed twigs; and he assumes that the adults oviposit on these herbaceous food plants of their young. In the Illinois valley sand region there are no wild conifers.

Systematic Notes.

Note 1, p. 230.—*Bacunculus blatchleyi*. Walsh described his *Diapheromera velii* from Nebraska males and Illinois females. Scudder, in his Catalogue, credits *velii* to Nebraska only. The common prairie species of Illinois and Indiana, which we have been calling *velii*, was represented in our collections mostly by female specimens, but it was noted that the males indicated either that our *velii* was not a typical *Diapheromera* or that it was a *Bacunculus*. Mr. A. N. Caudell has received from Mr. W. S. Blatchley a pair of alcoholic specimens taken in Indiana, and described them as *Bacunculus blatchleyi*. Mr. Caudell has kindly sent me a typical male *velii* from Kansas, and I can now say with certainty that our specimens, and also those in Mr. Blatchley's cabinet, which I had previously examined, are all *Bacunculus blatchleyi*, to which species Walsh's females probably belonged. It is an inhabitant of rank prairie vegetation like *velii*, while *femorata* is a forest species. I have also taken *blatchleyi* at Lake Geneva, Wis., as stated in the list.

Note 2, p. 231.—*Eritettix virgatus*? This single female agrees with Scudder's description and McNeill's key except that the supplementary carinæ of the pronotum are almost entirely obsolete. It is possibly a new species.

Note 3, p. 231.—*Ageneotettix scudderi*. Hancock ('06) has collected examples of *Ageneotettix* near Chicago, which, after comparison with a type specimen of *A. scudderi*, he has described as a new species under the name *arenosus*, suggesting that the Minnesota, Illinois, and Indiana *scudderi* of Lugger, McNeill, and Blatchley respectively are probably also *arenosus*. According to him, *arenosus*, as compared with *scudderi*, is smaller and more slender, with the vertex right-angled, not acute-angled as in *scudderi*, the foveolæ deeper, the tegmina slightly shorter, etc. He has evidently overlooked Bruner's

"Some New Colorado Orthoptera" (Bruner, '04), in which a key to this genus appears and *A. occidentalis* is described from Colorado. This is said to differ from *scudderi* "in its somewhat slenderer form and smaller size," in its "somewhat abbreviated tegmina and wings," and "in the fewer (9) spines on the outer row of the hind tibiæ." *Scudderi* is characterized in Bruner's key as having 10 or 11 spines in the tibial outer row and the vertex right-angled or obtuse-angled in both sexes, while in the remaining species, *deorum*, it is slightly acute-angled. It will be noted that the broad-angled vertex is used by Bruner to distinguish *scudderi* from *deorum*; and, on the other hand, by Hancock, to distinguish *arenosus* from *scudderi*. Apparently *arenosus* is not sufficiently distinguished from *occidentalis*, or from *scudderi* as defined by Bruner, and it seems best for the present to retain the name *scudderi* for our Illinois examples. Individuals from all the Illinois localities herein cited, as well as some taken in Wisconsin by Mr. J. D. Hood, agree sufficiently with Hancock's description of *arenosus*, as well as with Bruner's characterization of *scudderi* just cited. The vertex is usually slightly obtuse-angled. An examination of the spines in the hind tibial outer row of 12 specimens from various localities gave the following result: spines, 9–9 (1 specimen), 9–10 (2), 10–10 (7), 10–11 (1), 11–11 (1).*

Note 4, p. 233.—*Psinidia fenestralis*. Five eastern specimens of *fenestralis* (New Jersey, etc.) in the State Laboratory collections show varietal differences from Illinois examples. Our specimens are smaller—female, 19–23 mm., male, 14–17 mm.—as compared with the eastern examples—female, 25 and 27 mm., male, 18–19 mm.; and in our examples the wing band is farther from the base. In the eastern specimens it crosses the wing centrally, or a trifle nearer the base; the first convex radiate vein—that crossing near the wing center—is at least half in the band; and there is a broad hyaline space beyond the band, the apex immaculate in the female. In our examples the band crosses nearer the apex than the base; the first convex radiate vein is about two fifths in the band; and the hyaline spot beyond is small, the apex in the female with evident darker spots at the vein tips and in the subcostal region. In all the males the apex is blackish.

Note 5, p. 233.—*Trimerotropis citrina*. Our examples of *T.*

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* Rehn, in a paper received since the above was written (Proc. Acad. Nat. Sci. Phila., Vol. 58, p. 371), shows that both *scudderi* and *occidentalis* are probably synonyms of *deorum*.

maritima from New York and New Jersey have a very narrow wing-band, tapering out at the anal vein and falling far short of the anal angle; the tegmina are without definite indication of the two principal spots or bands; the dorsal hue is a dull pale sand-color; and the tibiæ are whitish yellow. Typical *citrina* (from Galveston, Tex., from Elizabethtown, Ill., on the Ohio River, from Meredosia and Havana on the Illinois, and from the Mississippi River shore from Grand Tower to Savanna) has a broad complete band approaching the anal angle; the tegmina have a pair of evident spots or bands; the general color is a speckled brownish; and the tibiæ are red to orange. In the State Laboratory collections are a number of examples labeled "N. Ill." which are intermediate between the two forms above described—the wing band narrow, but not interrupted except by the pale anal vein, a pair of inconspicuous small spots on the tegmina, the general color light, and the tibiæ pale lemon-yellow. One of this type, with yellow tibiæ, is from Henry, Ill., north of Peoria, on the Illinois River. This and a *citrina* from Bird's Point, Mo., were listed by McNeill in his "Orthoptera of Illinois" as *Circotettix verruculatus*. Collections of the lakeshore form of *maritima* were made by us along the beach of Lake Michigan at Waukegan in August, 1906, in time to include the results herein. These were closely like the somewhat intermediate form just mentioned as labeled "N. Ill."—probably, therefore, lakeshore collections also. The tibiæ were lemon-yellow, and identification as *maritima* seemed admissible. Mr. Shobe succeeded, however, in finding on the lake beach examples with well-marked orange tibiæ not otherwise differing from those with lemon-yellow tibiæ. This makes the line of division between the two species very indefinite.

Note 6, p. 234.—*Melanoplus macneilli*, n. sp. This was found only in a restricted area beside the blowouts on the Moline Sand Hill, associated with *M. flavidus* and *angustipennis*, to the latter of which it is closely allied. It was at once recognized by my assistant, Mr. Frank Shobe, and myself, as a new form because of its different thoracic and femoral coloring. The male terminal structures are about as in *angustipennis*, except that the furcula is very short and strongly divergent, and the apex rather narrowly rounded. The hind tibiæ are light blue, apically greenish. The species is about the size and color of *angustipennis*, perhaps a trifle smaller, but with two noticeable color differences. The entire ventral margin of the hind femora is strongly sanguineous, while in *angustipennis*

it is dull greenish yellow; and the dorsum of the thorax, especially in fresh specimens, is a lighter gray than in *angustipennis*, contrasting much more with the black lateral stripe. The dorsal margin of the hind femur is more distinctly banded than in *angustipennis*. The prozona is slightly narrower behind than in *angustipennis* and the metazona shorter. Apparently these differences require the formation of a new species, which I dedicate to the pioneer in this interesting local field.

Note 7, p. 235.—*Udeopsylla robusta*. The common *Udeopsylla nigra* of eastern Illinois is uniform black or piceous, except for some faint rufous thoracic spots. Examples of *Udeopsylla robusta* from South Dakota are rufo-testaceous throughout, except for being darker in front of the sutures. The male and female taken near Havana are mahogany-brown, darker at the sutures; the face, legs, and ovipositor are rufo-testaceous, about as in the South Dakota specimens, but the outer faces of all the femora are indefinitely striped and mottled with the dark mahogany color, not uniformly pale as in typical *robusta*. The tibiæ and tarsi are just as in typical *robusta*, while those of *nigra* are no paler than the dorsum. The Havana pair are clearly not *nigra*, and for the present may be regarded as a variation of *robusta*. The eastward range of *robusta* is thus extended across the Mississippi. That of *nigra* reaches certainly about to the Indiana line, and probably far beyond it.

Note 8, p. 235.—*Nemobius fasciatus vittatus*. As I have elsewhere stated ('06), we may recognize three forms of wing development in *Nemobius* by adding an intermediate form to the usual macropterous and brachypterous types. In the intermediate form the wings are aborted as in the brachypterous form, but the tegmina are long, as in macropterous individuals, the dorsal field at apex ampliate and much exceeding the tip of the lateral field, not truncate. The specimen from the Devil's Neck is of this form.

Note 9, p. 236.—*Nabis elongatus*, n. sp. Length, 10 mm.; width, 2 mm. Elongate, with whitish pubescence, minute and sparse on upper surface, surface yellowish white above, a dusky stripe extending from between the antennæ to the tip of the scutellum, broader and darker posteriorly, especially on the scutellum; hemelytra attaining the base of genital segment, wings but slightly shorter, hemelytra whitish without fuscous dots, veins of membrane faintly bordered with fuscous on basal part, a dark spot at base of membrane on inner margin; tergum fuscous, darkest medially, becoming

yellowish laterally. Beneath, dull yellowish with broad lateral fuscous stripe, bordered on the metastethium by a whitish stripe edged within by a dark line.

Head nearly as long as the thorax medially, a little more than three times as long as the width between the eyes; first antennal joint about as long as the head, antennæ yellowish, apex of second joint and remaining joints feebly infuscated; pronotum about as wide at base as its length.

Legs pale dull yellowish, femora rather slender, the anterior and middle ones gently tapering towards apex, the posterior one subcylindrical, all dotted with fuscous spots, tibiæ with some fuscous points, apex of tarsi, and claws black; fore femora slightly longer than head and pronotum conjointly.

Abdomen about four times as long as broad, the genital segment parallel-sided, one half longer than broad, with dark median line on apical three fifths; male hamule about as figured by Reuter for *vicarius*, with a lobate extension of the margin in a lower plane, on the ventral side beneath the junction of the petiole and the semicircular lamella.

Taken along the sandy river margin in the lower part of Havana, Ill., June 9, 1906. Type in coll. Ill. State Lab. Nat. Hist.

This macropterous male is near *vicarius* Reut., which was described from Illinois, and is by some united with *propinquus* Reut.* Both were described from the brachypterous form. Professor Herbert Osborn thinks our specimen can not be *vicarius*, and I have decided to describe it as new.

†*Ligyrocoris constrictus*. (See page 237) The species thus listed by me is that commonly so identified in Illinois collections. All examples at hand, however, clearly lack the stridulatory vitta of *Ligyrocoris*. It is not *Perigenes fallax*, which resembles *Ligyrocoris* and also lacks this vitta, but is larger, broader, and otherwise different.

†*Phlegyas annulicrus*. (See page 237) This is our common *Peliopelta abbreviata*, now catalogued as a synonym of *annulicrus*. I have not verified the occurrence of *annulicrus* in the sand region if

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**Propinquus* and *vicarius* were originally described on the same page, *propinquus* first. Reuter in a later article made *vicarius* a synonym of *propinquus*, but Lethierry and Severin list the species under the name *vicarius*, giving *propinquus* as a synonym.

†The two notes without serial number were added after the printing of the list.

it be a western species distinct from *abbreviata* as suggested by Van Duzee ('05).

Note 10, p. 238.—*Euschistus variolarius*. In a study of the genus *Euschistus*, I noted examples of an apparent variety of *variolarius* having the usual black terminal ventral dot of the male, but with small black dots at the sutural intersections of the abdominal margin as in *fissilis* and other species. The humeral spines are very prominent in these specimens, and the lateral edge just in front of the spines is concave or straight instead of being more or less convex. This variety is represented in *variolarius* from H.2 and 3.

Note 11, p. 239.—*Homaemus aeneifrons*. In this genus the general aspect of the punctuation varies to a remarkable degree. The surface pattern is formed by sudden changes in the density of the punctures, emphasized by contrasting shades of the ground color, which also varies excessively in distinctness, from sharp contrasts to their almost total obliteration; but its form is nevertheless very constant for each species. The differences in the median scutellar pattern may be tabulated as follows:

Median pale line of scutellum rather suddenly widening back of middle into a broad medio-apical stripe.
- Medio-apical stripe parallel-sided, the dark adjacent color gradually shading off. Length, 7–8 mm. - - - - *aeneifrons* Say.
- Medio-apical stripe usually narrowing posteriorly, margined by a dark line. Length, 4.5–6 mm. - - - - *grammicus* Wolff.

Median pale line gradually widening into a narrow medio-apical stripe. *bijugis* Uhl.

Median pale line very narrow or interrupted at posterior third of scutellum, in front of and behind this usually very distinct, posteriorly spread out fanlike or broadly subtriangular and gradually darkening, to apex. *proteus* Stal.

Proteus is readily recognized also by the deep notch in the flap like anterior extension of the prosternum each side of the middle.

Note 12, p. 242.—*Harpalini*, n. sp. This interesting carabid appears to be generically and specifically new. It belongs to the tribe *Harpalini*, but as the single specimen obtained is a female, its systematic place is uncertain, and it does not seem advisable to do more at present than to call attention to its striking peculiarities.

It is about the size of *Harpalus testaceus*, but even paler than that species, yet apparently perfectly matured; the thorax has the

well-rounded angles and the form of that of *Harpalus herbivagus.* Unlike *Harpalus*, however, it has three dorsal series of elytral punctures, 4 or 5 in each row, located on the 3d, 5th, and 7th intervals. The tibial and tarsal angles are not prolonged; the fore tarsi are spinulose beneath, slightly dilated; the first joint of the hind tarsi is not elongate. The antenna has the proximal two joints glabrous; the eyes are rather small; the left mandible is chisel-shaped, slightly overlapping the right; the labial palpi are plurisetose in front, the last joint slightly shorter than the preceding one; the mentum is acutely toothed at middle, its epilobes are narrow, and it has a single setigerous puncture at each posterior angle.

Note 13, p. 243.—*Hyperaspidius trimaculatus.* In this specimen the two pale vittæ—lateral and sutural—of each elytron are at base slightly broader but not united, the three black intervals of equal width at base.

Note 14, pp. 243, 244.—*Calopteron.* I offer the following key to facilitate the separation of these two species.

Apical part of third vein ot elytra within the black band raised on an elevated ridge like that of the second and fourth, ridge ending rather abruptly; no middle band in our specimens. - - *terminale* Say.

Apical part of third vein within the black band not on a distinctly elevated ridge, the interval concave from the second to the fourth veins; middle band present or wanting. - - - - - - *reticulatum* Fabr.

Note 15, p. 244.—*Lucanus placidus.* This species may readily be separated from *dama* as follows:

Mandibles of male rounded, ecarinate; of female strongly carinate on the inner side of the dorsal surface—especially over the subapical tooth—and usually a lower carina along its outer margin; top of head of female anteriorly rugosely punctate and very opaque; elytra and thorax shining. *dama* Thunb.

Mandibles of both sexes subtriangular in cross-section, their dorsal surface concave, with a strong carina along its outer margin only; the inner edge sharp, bidentate in the female and multidentate in the male; entire dorsal surface of insect with dull luster. - - - - - *placidus* Say.

Note 16, p. 248.—*Phacepholis candida.* Dr. Horn described this from two specimens as "nearly white." It has, in fact, a color pattern similar to that of *obscura*, in pale brown and white. The thorax has a dorsal darker stripe divided by a fine median white line, and lateral and ventro-lateral darker stripes. The elytral scaling is very pale golden-brown, with two vague stripes and the

lower margins white. The scales beneath are nearly white, without evident pattern.

Note 17, p. 251.—*Laphystia 6-fasciata*.—Dr. Williston says (Trans. Am. Ent. Soc., Vol. 12, p. 53): "Specimens of this species from Montana differ appreciably from those from the Southern States that I have seen. In all the northern specimens the pollinose bands of the abdomen are all entire, while in the southern ones they are mostly interrupted; the femora, moreover, in the former are mostly yellow, while in the others they are chiefly black. These differences, if not sufficient to warrant specific separation, may be varietally indicated by the name *notata* Bigot for the southern form." In our specimens the femora are reddish and the fifth abdominal band is clearly interrupted.

Note 18, p. 254.—*Sphærophthalma chlamydata*. Melander ('03) collected "several" specimens of a male mutillid in the sand region about Bath (designated in this list as H.3) which he determined as *bioculata*, and of a female, described by him as new under the name *chlamydata*. Ten of my 16 unassigned males are his *bioculata*, and 61 of the 83 unassigned females are his *chlamydata*. On one occasion one of these males was seen dancing in attendance upon a female *chlamydata*, both being then captured. Their occurrence is coincident, and they have close similarities in vestiture. It would seem proper to accept them as two sexes of one species. However, *bioculata* in the West has been connected by Cresson with quite a different female, which Fox conjectures may be the same as *creusa* Cresson. Since the females are more reliably separable than the males, it would seem best for the present to retain the name *chlamydata* for both sexes in our region.

Note 19, p. 254.—*Sphærophthalma macra*. The single example which is assigned to this species has an evident coarse orange pubescence on the second segment, the dorsal reddish area of which does not seem to be two partly confluent spots as is the case in the more common types assigned to *ferrugata* and *agenor*, in which also the pubescence is yellowish and not evident when viewed vertically from above.

Note 20, p. 255.—*Ammophila argentata*, n. sp. The sides of the thorax are covered with a mat of uniform silvery pubescence, its dorsum is less conspicuously silvery pubescent; the face is silvery, the red or yellowish of the abdomen extends from near the base of the second joint to beyond the middle of the fourth, or even upon

the base of the fifth; the legs are wholly black; the thorax is rather sparsely punctate; the metanotum is finely and densely obliquely striate; the wings are yellowish hyaline. Length, 18–21 mm. One male, three females, Mason Co., Ill. Type in coll. Ill. State Lab. Nat. Hist.

Note 21, p. 256.—*Bembidula capnoptera.* The single example agrees with the description of this species except that the abdominal yellow bands are of good width, about equal to the intervals between them, and all rather narrowly interrupted at middle.

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ERRATA.

Page 141, line 11, for *Pl. V.* read *See Map.*

Page 144, line 8, for *Pl. V., VI.* read *See Map and Pl. XXII.*; and line 9 from bottom, for *Pl. VII.* read *Pl. XXIII.*

Page 201, line 7, for *northeastern* read *northwestern.*

Page 246, lines 3, 7, and line 4 from bottom, and page 248, lines, 1, 14, 20, and 23. for *Œnothera* read *Onagra.*

VIII.

Eighty-acre field occupied by blow-sand and blowouts. Original bunch-grass prairie in the foreground: in the distance, black-jack forest.—A typical locality for the characteristic blow-sand fauna.

IX.

A large blowout in which a large cotton-wood tree has grown. Sand has filled two-thirds of the blowout, covering the cottonwood to its lower branches, and has been partially fixed. Upon the filled part, in the left foreground, the formation of a second blowout has begun.

X.

A butternut-tree covered to its lower branches with sand removed from a blowout.

XI.

Front slope of an advancing dune covered with the tumbleweed, *Cycloloma*. On the crest, a dense clump of *Rhus aromatica*. The tree is an American elm.

XII.

FIG. 1. Blow-sand entirely without vegetation. A grove of walnuts (*Juglans nigra*) in the rear.

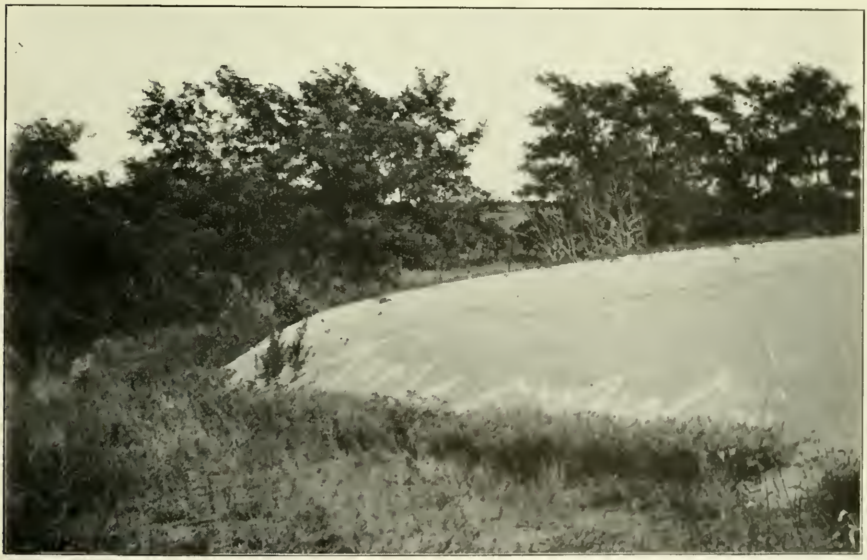
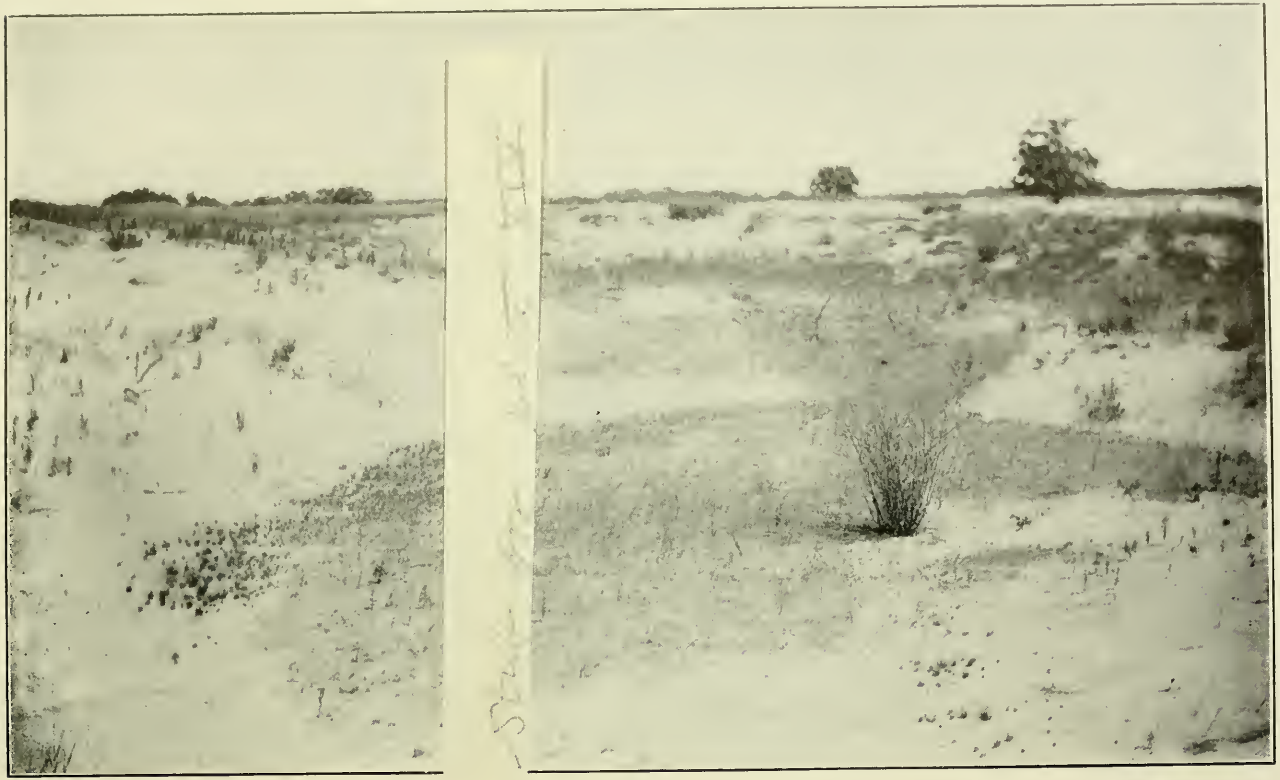


FIG. 2. Traveling dune formed of sand removed from a blowout. A small thicket of plum-trees has been partially buried and the trees killed. A dense zone of *Diodia teres* grows around the edge. *Robinia pseudacacia* cultivated in the background.—The zigzag line at the edge of the sand is the track of a box-turtle (*Cistudo carolina*).

XIII.

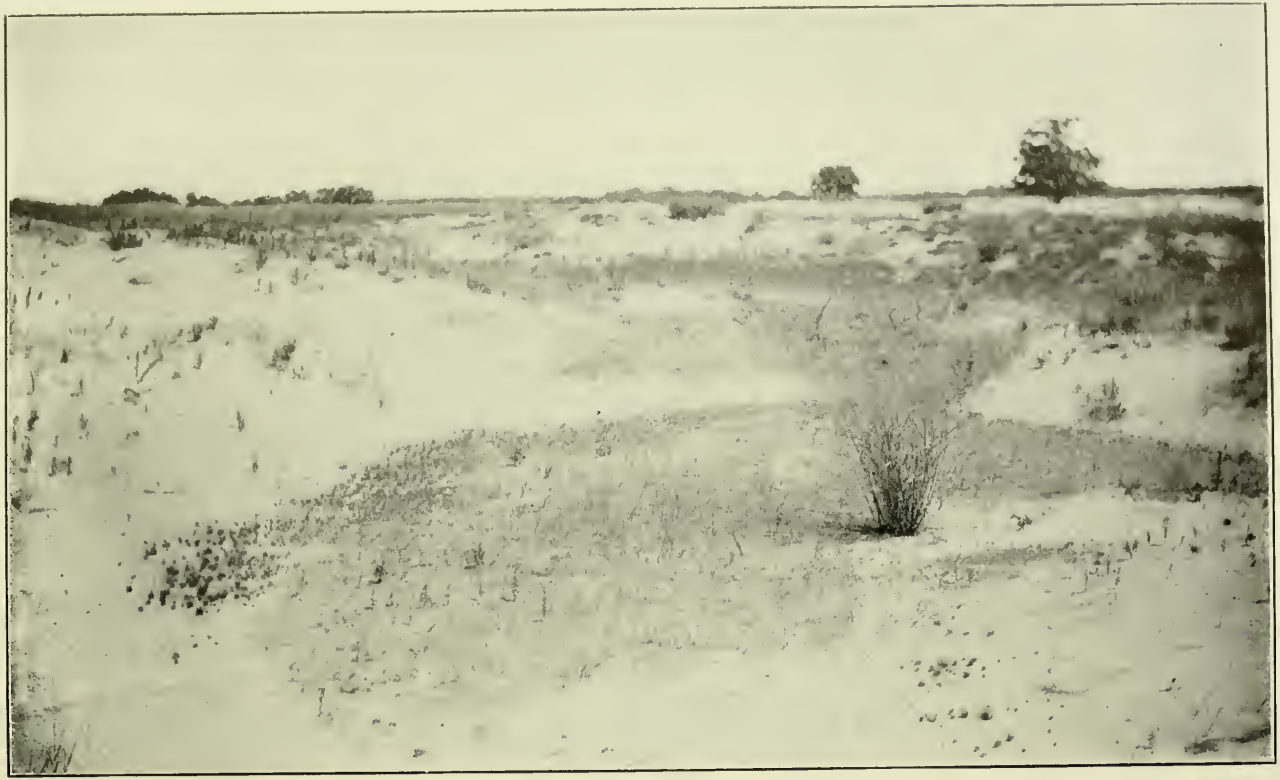
Level tract of blow-sand, almost devoid of plants. Invasion of *Ambrosia, Cenchrus, Commelina*, and other species, from the margin.—*Corimelæna ciliata* abundant in sand about roots of grass tufts in foreground.

XV.



Early stage of a blowout association. The floor o out is covered with a carpet of *Stenophyllus capillaris*, and in its center is a large bunch of *Panicum virgatum*.—A fine field for sa such as *Cicindela*, *Mutillidæ*, *Melanoplus flavidus* and *M. angustipennis*, *Sphar-agemon wyomingianum*, *Ag* *scudderi*, *Psinidia fenestralis*, *Anthrax*, *Asilidæ*, *Pompilidæ*, etc.

XV.



Early stage of a blowout association. The floor of the blowout is covered with a carpet of *Stenophyllus capillaris*, and in its center is a large bunch of *Panicum virgatum*.—A fine field for sand insects such as *Cicindela*, *Mutillidæ*, *Melanoplus flavidus* and *M. angustipennis*, *Spharagemon wyomingianum*, *Ageneotettix scudderi*, *Psinidia fenestralis*, *Anthrax*, *Asilidæ*, *Pompilidæ*, etc.

XVI.

Bunch-grasses dislodged by wind-action, and drifting into a shallow blowout. The dense flattened bunches are an unidentified *Panicum*; the large bunch at the right is *Sorghastrum avenaceum*.—A typical locality for ***Stachyocnemis apicalis***, *Cicindela*, ***Mutillidæ***, *Anthrax*, etc.

XVII.

Final stage of the blowout succession, showing a typical black-soil prairie association. A small box elder has also appeared.—*Bacunculus blatchleyi*, *Mermiria neomexicana*, *M. bivittata*, and *Schistocerca alutacea* in the long grass.

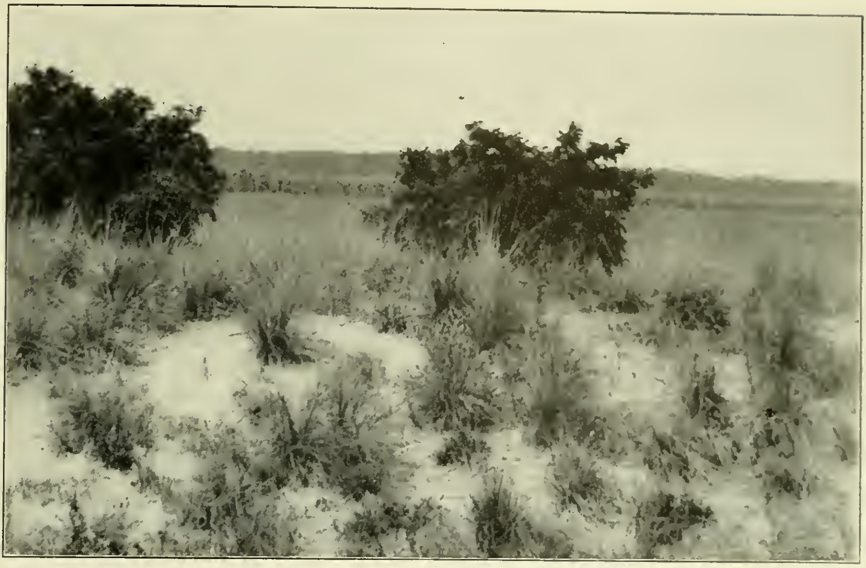


FIG. 1. Bunch-grass association (*Stipa spartea*) on top of a hill, showing the open character of the vegetation. The trees in the background are not native.—*Melanoplus angustipennis*, *Ageneotettix scudderi*, *Mestobregma thomasi*, *Hippiscus rugosus*, and *Mutillidæ* are common, and in early summer *Hippiscus phœnicopterus* and *H. haldemanii*. *Conocephalus robustus* also occurs here.

FIG. 2. A single plant of *Sporobolus cryptandrus* growing on blow-sand has built up a conspicuous mound beneath it.

Fig. 1. A low mound of sand held in place by *Rhus aromatica.* Several other species grow in the protected sand on its lee side. The small plants in the left foreground are *Commelina virginica.*

Fig. 2. A dense thicket of the sand-binder *Rhus aromatica.* The tumbleweeds, *Cycloloma atriplicifolium,* are the only plants on the blow-sand in front.—Upon the *Rhus* are *Blepharida rhois* and its larvae, *Perillus circumcinctus* and its nymphs, *Resthenia insitiva,* and the predaceous *Zelus socius.*

XX.

Fig. 1. *Populus Dilatata* spreading by suckers over the blow-sand into the blowout. *Cristatella Jamesii* grows in abundance in the right foreground.—Upon the *Populus* are *Metachroma parallelum* and *M. angustulum*.

Fig. 2. A dune has invaded a walnut grove. The ground cover on the moist shaded sand is mainly *Solanum nigrum* and *Sicyos angulatus*.—Under logs are *Ischnoptera inæqualis*, *Udeopsylla robusta*, *Pangæus*, etc.

XXI.

Fig. 1. Interior of a black-jack forest.—On the ground are *Melanoplus fasciatus*, *M. luridus*, and *M. impudicus*, and under gatherings of dry leaves *Gryllus* is abundant. Along the forest margins are *Schistocerca alutacea* and *Hippiscus phœnicopterus*.

Fig. 2. Interior of a mesophytic forest of white oak and bur-oak on a sand ridge extending along the low marginal bluff of the sand plain bordering the Illinois River.—On the ground are *Melanoplus scudderi* and *Spharagemon bolli*.

XXII.

Illinois River flood-plain at high water, as seen from the margin of the sand plain above Havana, Ill., looking westward. In the distance are the western upland bluffs, and at the left of these is the lower end of the valley of Spoon River.

XXIII.

Margin of sand plain just below Havana, Ill., here forming east bank of the Illinois River. Areas of mesophytic forest are near the margin.—On the sandy beach is *Trimerotropis citrina*; on its moist margin are *Cicindela cuprascens*, *C. hirticollis*, and *Paratettix cucullatus*; on the small willows at the water's edge are *Metachroma* and *Melasoma*; and under driftwood, *Chlænius*, *Patrobus*, and numerous other *Carabidæ*.

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ON THE LOCAL DISTRIBUTION OF CERTAIN ILLINOIS FISHES: AN ESSAY IN STATISTICAL ECOLOGY.

BY

S. A. FORBES, Ph.D.

Article VIII.—*On the Local Distribution of certain Illinois Fishes: an Essay in Statistical Ecology.* By S. A. Forbes.

An animal society is composed of animals habitually occurring together in the same locality and the same class of situations. Such an association is, of course, composed of many species, variously related to their special environment, some attracted to it by one set of conditions and some by another. Although their local haunts may be virtually identical, their ecological relations, if determined in detail, may prove to be very different. A pike and a minnow may be members of the same associate group, to whose habitat, however, the pike is especially attracted by the minnow, and the minnow by the facilities which are offered there for concealment or escape from the pike.

It is usually possible to learn the contents of a local association of plants by simple inspection and enumeration; but animals come and go, elude observation, and refuse to be numbered, and the details of their associate occurrence can only be learned indirectly, by means of sample collections preserved for subsequent study. If the situations from which such collections are made are carefully chosen and correctly classified, and if the collections themselves are full enough, uniform enough, and numerous enough to be fairly representative of each situation, the essential facts concerning the assemblage of animals corresponding to any unit of environment may be readily made out. The making of such collections for such a purpose is, however, a relatively new thing, and scarcely a beginning has been made in the systematic study of animal associations by this method.

A knowledge of definitely circumscribed, or merely measurably distinct, local associations does not, however, by any means exhaust the subject of associate relations, for the animals of a region can not be wholly divided up into such definite

societies, and such society groups as can be clearly recognized rarely have any precise boundaries. For a full knowledge of the intricate web of the relations to their physical environment, and through that to each other, of the animals of any composite area, it is necessary that the entire assemblage of the inhabitants of that area should be studied as a compound unit, and for this, of course, extensive and comprehensive collections must be made, such as will fairly represent the entire animal life of their region.

The possession of a miscellaneous but very large collection of Illinois fishes, obtained during various seasons of a long period of years, from all kinds of waters and in all parts of the state (see Map I.), each lot still bearing, as a rule, the original collector's data giving both the time of collection and the exact locality, has suggested to me a trial study, intended to show what may be learned with regard to the ecology of fishes by a critical analysis of the local data of such a collection.

These data may be organized and generalized for ecological study in two ways. They may be treated in one mass, without local subdivision, and in such a way as to bring out the facts concerning the association of the different species of fishes with each other, without reference, in the first instance, to the localities and situations from which the specimens have been taken; or they may be first divided and arranged according to location and surroundings, the assemblage of species from each geographical unit and from each kind of ecological situation being studied separately, as a local animal society. The first method has the advantage over the second, that it gives us much larger numbers of specimens and collections from which to generalize, and thus enables us to enter further into the details of the associate relationship without danger of error from unsafe generalization; and it also enables us to distinguish similarities and differences of ecological relationship among the species, uninfluenced by any previous discrimination or classification of ecological situations. The second method has the advantage over the first, that it attacks the problem more

simply and more directly, and, if the data are sufficient, reaches results more immediately and obviously significant.

I have used both these methods in the present paper, comparing the results of the two in a way to make the one set account for and explain the other. This paper is thus to be taken as a contribution to an answer to the following questions: What Illinois fishes are habitually found in each others' society, and what is the relative frequency of their associations? How are Illinois fishes grouped and distributed according to location and situation, and in each ecological assemblage so formed what is the proportionate representation of its various constituent species? How far are the two classes of data, those of associative affiliation and of ecological relationship, comparable, and to what extent may the one be used to explain the other? An answer to these inquiries would enable us to recognize, define, and account for associate groups among our fresh-water fishes, and also to distinguish those members of each group which, being most frequently and most strictly associated, are most characteristic of it. It has, in fact, been a part of my undertaking to find a method of distinguishing clearly these central or typical members of an ecological assemblage, and to express numerically the intensity of the influence—the strength of the bond—which holds them to the local situation, as compared with the more lax or less continuous forces influencing what we may call the outlying members of the group.

Studies of this description may be expected to give us significant information, also, concerning the competitions of associated species, and concerning the evasions of competition, and the escape from its consequences, by those closely related and similarly endowed, and concerning the niceties of adaptation, psychological, physiological, and structural, exhibited by fishes inhabiting a notably uniform area.

Associative Relationships among the Etheostominæ.

For a preliminary and sample study of this description, I have chosen first a subfamily of our fishes, the *Etheostominæ*—or darters, as they are commonly called—and have endeavored

to learn to what extent the species of this subfamily are ecologically affiliated, which of the species are most typical of the subfamily as an ecological group, which are to be regarded as lagging or wandering members of it, and which, if any, do not belong ecologically with their taxonomic relatives.

I shall be obliged, in these studies, to assume provisionally that my collections are large enough and numerous enough fairly to represent actual field conditions in Illinois, and that they are so numerous that they may reasonably be treated, for the present purpose, as homogeneous and similar, each collection as a unit substantially like every other, important differences among them disappearing, in aggregates and averages, by the process of mutual cancelation. In other words, I must assume provisionally, testing my supposition later by the constancy and reasonableness of the results, that these random samples of Illinois darters represent the subfamily as a whole sufficiently well to justify their use as materials for a study in statistical ecology.

The Method of the Investigation.

The species of darters which are most frequently found in each others' company are, of course, those most likely to be closely related ecologically; and the ratio of the number of collections containing both of any two species to the total number of collections containing either, may be used as a provisional measure of the ecological affinity of the two.

Furthermore, given a certain average frequency of occurrence of each of two species inhabiting a common territory, and assuming a uniform distribution of each in this territory, uninfluenced by ecological relationships, the average frequency of the joint occurrence of these species in collections may be computed; and any very marked departure, positive or negative, from this computed average will point to some ecological bond if the difference is positive, or to some cause of ecological separation if it is negative.

If, for example, it appears that several species ought to be found together, on an average, in one out of twenty of our col-

lections, provided that they are distributed over their common area uninfluenced by causes tending to bring them together into the same situations, and if the actual average of the joint occurrences of the species is one in every five collections, then the associative bond of the species concerned may be given the value of four—a value of little significance perhaps, taken by itself, but useful, at any rate, for a comparison of the darters with other groups. And if certain of the species are associated with the other darters in an average ratio of five to one, while other species are associated with the other darters in an average ratio of only two to one, then the former species will typify the ecological group more definitely and correctly than the latter.

By this means, also, if the actual frequencies of joint occurrence of the various species of the group be compared with the computed average of such frequencies, the division of any presumably single group into two distinguishably separate ones might be made out. If it should appear, for example, that the species of darters may be divided into two groups, each of which taken separately is found to have a mutual associative ratio of six to one, while the corresponding ratio between the two groups themselves is but three to one, we may infer provisionally the division of the darters into two ecological groups, distinguishable by their predominant attraction to different sets of ecological factors in their common environment, but united in turn in one larger group by their common attraction to certain other factors.

For an analysis of the facts, we need for each species of darter a determination of the average frequency of its merely chance occurrence in collections with each of the other species, a determination of the actual frequency of these joint occurrences, and a numerical expression of the ratio of one of these frequencies to the other. Then by a systematic tabulation of these latter ratios, which may be called the *coefficients of association*, we may compare one species with another, and bring the essential data for the whole family under the eye for convenient inspection and analysis.

For the computation of these ratios, I have used, with two exceptions to be presently stated, the thousand Illinois collections most available for these studies, excluding five hundred and forty-four additional collections, which, because of imperfect data and for various other reasons, are undesirable material. I find that the species *Hadropterus aspro* has been taken in 159 of these thousand collections, which ratio of average frequency may be expressed by the fraction .159; and that the species *Hadropterus phoxocephalus* has been taken 85 times, which gives a frequency ratio of .085. That is, in any thousand similar miscellaneous collections distributed over the area inhabited by these species we may, according to these data, expect to get the first species 159 times and the second species 85 times; and the chance that any single collection will contain the first species is .159, and that it will contain the second species is .085. From this it follows that the chance that the two species will occur together in any single collection of the thousand, provided that the distribution of each is arbitrary and accidental with reference to that of the other, is the product of these fractions; and the probable number of chance joint occurrences of the two species in the thousand collections is, of course, a thousand times that product, or 13.515. As a matter of fact, however, these two species were found together in my collections 40 times instead of approximately 13.5 times, or three times as frequently as there was reason to expect provided that there had been no associative bond between the species. This number 3, indicative of the frequency of actual association as compared with the chance or accidental, is the coefficient of association for these two species. If the numbers of presumable and actual joint occurrences were equal, this coefficient would evidently be 1, in which case no associative bond would be indicated; and if it were notably less than 1, we should have some reason to suppose that the two species belonged to different ecological groups—that their ecological affinities and relationships tended to separate them instead of to bring them together.

The computation may be facilitated by the use of algebraic symbols.

Let a equal the total number of collections to be used in the computation; b, the number of collections containing the more abundant of two species to be compared with one another; c, the number of collections containing the less abundant of these species; and d, the number of collections each of which actually contains both species together. Then $\frac{b}{a}$ expresses the chance that any collection of a will contain one or more representatives of the first species; $\frac{c}{a}$, the chance that any collection will contain one or more representatives of the second species; $\frac{bc}{a^2}$, the chance that any collection will contain one or more representatives of both species at once, provided that the distribution of each is ecologically independent of that of the other; and $\frac{bc}{a}$, the probable number of chance occurrences of the first and second species together in the number of collections represented by a, the same proviso being made. Since $d =$ the actual number of such joint occurrences, $\frac{ad}{bc}$ is the formula for the ratio of actual to calculated joint occurrences—the formula, in other words, for the computation, in all cases, of our coefficients of association. For example, substituting in this formula the values already given for *Hadropterus aspro* and *Hadropterus phoxocephalus*,

$$\frac{ad}{bc} = \frac{1000 \times 40}{159 \times 85} = 2.96.$$

To determine the coefficient for any pair of species, we need only to know their separate frequencies and their joint frequencies in collections derived from the territory of their common distribution.

The above formula may be translated into the following rule for finding the coefficient of association of any two

species: *Multiply the number of collections made from the common area of the species by the number containing one or more representatives of both; multiply the number of collections containing one or more representatives of one of the species by the number containing one or more of the other; and divide the first product by the second. The quotient will be the coefficient of association.*

Discussion of Associative Tables.

I have computed, by the above-described method, for thirteen species of Illinois darters—each of which was obtained more than fifteen times in my collections—the coefficients of the association of each species with each of the other twelve, and have arranged these seventy-eight coefficients (apparently one hundred and fifty-six, since each of them is entered twice) in Tables I.–V. for comparison and discussion. In computing the coefficients of two species, *Diplesion blennioides* and *Etheostoma zonale*, the first of which is found only in the eastern part of the state and the second only in the northern half, I have used as the value of a in my formula, not the entire number of collections made throughout the state, but the number made in the stream systems in which these species occur.

In Table I. the coefficients in each column are in serial order, the highest to the lowest from above downwards; and the columns for the several species are placed in the order of the average coefficients for the columns, the highest at the left.

We notice first, that the total of the one hundred and fifty-six coefficients of this table is 315.8—a general average associative coefficient of 2.02 for all the thirteen species. As the normal chance average would be but 1, we conclude, from these data, that darters were found together in my collections about twice as frequently as mere chance would indicate. This ratio of 1 to 2 is thus an approximate and provisional measure of the ecological bond in this family taken at large.

We notice next, the unlike totals and averages of the coefficients for the several species, these running from 1.22 to 2.69—an indication that the associative bond is more than 2.2 times as strong for *Hadropterus phoxocephalus* and *Etheostoma*

zonale as for *Boleichthys fusiformis* and *Boleosoma camurum.* On the other hand, we find no species in which the average coefficient of association is less than 1—no indication that any of these twelve species are wholly drawn away from their family by stronger ecological affiliations with some other group. Nor do we find, in passing from the more strongly associated species to those less strongly associated, any abrupt transition in the series—a fact which may be taken as evidence that the darters of my list are a unitary group, of which certain species are ecologically more typical than others, having, that is, the darter habits and relationships more fully developed and more strongly fixed.

Typical and Non-typical Darters.

The more typical species of this list seem to be the following six, mentioned in the order of the size of their coefficients of association: *Hadropterus phoxocephalus*, *Etheostoma zonale*, *Etheostoma flabellare*, *Hadropterus aspro*, *Ammocrypta pellucida*, and *Etheostoma cœruleum*, the associative coefficients of which average 2.48. Apparently the least stringently connected with their kind by the associative relation are *Diplesion blennioides, Etheostoma jessiæ*, *Boleosoma camurum*, and *Boleichthys fusiformis*, the average coefficient of which is 1.36.

Furthermore, those least strictly associated with darters in general are not especially strongly associated with each other. Of the four species just mentioned, six pairs may of course be made, and the average of the coefficients of these six pairs is 1.33—less by .69 than the general average for the entire group (see Table III.). If we similarly pair the six species which I have selected as most typical, and average the fifteen coefficients of these pairs (see Table IV.), we get a general coefficient of 3.47—more by 1.5 than the average for the group. That is, those species which are laxly associated with the darters in general, are also laxly associated with each other; while those which are strongly associated with darters in general, are still more strongly associated among themselves. This last fact was to be anticipated, since in making up the special average coeffi

cients of those species which exhibit strong associative affinities we omit those which have the weaker affinities, and so have a group of select associates whose average coefficient must be higher than that of the whole thirteen species, including, as this does, some with strong and others with feeble associative tendencies.

The same fact is illustrated in Table II., in which all the coefficients of the seventy-eight possible pairs of my thirteen species are arranged in the order of the magnitude of their coefficients of association with *Hadropterus aspro* (1421). Taking the first twenty-one coefficients of the six most frequent associates of *Hadropterus aspro*, we find that they average 3.27, while the last twenty-one coefficients of the six least frequent associates of *Hadropterus aspro* average 1.4. That is, the twenty-one coefficients at the upper left angle of Table II. (above the black line) average two and a half times as much as the twenty-one coefficients at the lower right angle of that table (to the right of the black line). The most frequent associates of this species are associated with each other about two and a half times as frequently as are its least frequent associates.

It is also significant that five of the list of six most frequent mutual associates made up from Table I., are the same as those of the corresponding list made up from Table II., of *Hadropterus aspro* and its five closest associates, the two tables containing the same figures, differently arranged. We further notice that the three least frequently associated species are the same on both lists. Whether the data indicating frequency of association are arranged under each species independently, in the order of frequency, as in Table I., or with reference only to a single leading species, as in Table II., the results are nearly identical as to the darters most typical and least typical of the group.

Sufficiency of the Collections.

With respect to the sufficiency of the collections for the use which is here made of them, some additional evidence may be found by tabulating separately the seven species which appear least frequently in them—ranging in number of occurrences

from 16 to 60, with an average of 34—and comparing the average of their coefficients of mutual association with the general average coefficient for the entire group, with its 82 occurrences to the species. From Table V. it appears that this general coefficient for the seven least frequent species taken separately is 1.85, while that for the whole group of thirteen (Table I.) is 2.02—a coincidence probably as close as could be expected in view of the fact that the former number is an average of only 21 coefficients and the latter of 78. The coefficient expressing frequency of mutual association among these least frequent species, is thus so close to the general coefficient for the entire group that even the former species may be said to occur frequently enough in the collections for the purposes of this discussion.

Relations to Physical Environment.

I have next to study the interrelations of this group of darters by means of another and widely different set of data, to be derived from an analysis of collectors' records concerning the kinds of waters and the classes of situations from which the several collections came; and to compare the conclusions thus reached concerning the physical relations of the species with those already derived from an analysis of their relations of association. For this purpose these records have been organized in a way to show the relative frequency of the occurrence of each species in our collections in each of the three sections—northern, central, and southern Illinois, as the state is commonly divided; in each of the ten stream systems, or river basins, distinguished by us; and in each kind or class of body of water—whether stream, lake, pond, or marsh—the classification made expressing differences in size, in water movement, and in the character of the bottom.

Equalization of the Data.

The data available are not equally numerous under these various heads. Those concerning the size and general character of water bodies, and the distribution by stream systems

and sections of the state, are inclusive of all our collections; but in many cases data are wanting definitely *descriptive* of the waters and the situations from which the collections were made. This is owing to the fact that the present use of these materials was not foreseen in the beginning of our collection period, nor, indeed, until the greater part of the field work had been done, and the records of the earlier years are consequently often incomplete for the present purpose. Later, collectors were instructed to make full descriptive notes, from the ecological standpoint, of each body of water visited and of each location at which a haul of the seine was made, and the whole body of the data of local distribution and ecological preference is such that if used with due discretion it may be expected to throw considerable light on the associative relationships of this little group of fishes.

These data have been worked out, in the same manner as in the preceding section of this paper, in the form of percentages of frequency of the occurrence of each species in each geographic or hydrographic subdivision and in each ecological situation. As the numbers of collections made have varied widely for the several areas and situations, those from one being often many times as numerous as those from another, it was necessary to reduce the frequency ratios of the several species in each area to a common standard for comparison. These numbers have been equalized, and confusing discrepancies removed, by reducing the collection data to percentages of the same base, which, for convenience, has been made one hundred collections.

Discussion of Ecological Tables.

If equal numbers of miscellaneous collections had been made from each situation, and if the total number of collections were such that any given darter had been taken one hundred times, what number or percentage of these collections of darters would have come, according to my present data, from each of the situations represented?

The figures in Table VI. are answers to this question; and

when I say that 63 per cent. of our collections of *Hadropterus phoxocephalus* are from rivers and 26 per cent. from creeks; or that 94 per cent. of them are from waters with a bottom of rock and sand and only six per cent. from mud; this means that if miscellaneous collections of fishes of all descriptions had been made from all kinds of Illinois waters until one hundred of them contained darters of this species, then sixty-three of the hundred would have come from rivers and twenty-six of them from creeks, ninety-four of them from rock and sand, and six of them from mud.

The ratios of this table differ in significance from those of my tables of associative coefficients in the fact that while the latter exhibit various degrees of *associative* relationship between species, the former express the tendencies or preferences of the species with respect to the features of the *physical* environment. An understanding of these physical relations of a species must help us to understand and explain its associative relations, and the one set of data may be expected to serve as a test of the completeness and correctness of the other.

The Darters as an Ecological Group.

It is well known that the darters as a group are most likely to be found in comparatively swift and rocky streams, and that they are especially adapted, by their small size, their large paired fins, their pointed heads, and their habit of resting on the bottom, for maintaining themselves in swift currents, and for securing from among and under stones the insect larvæ and crustaceans on which they mainly depend for food. This fact is clearly reflected in my Table VI., of "Local Preferences of Darters", from which it appears that 70 per cent. of our collections of the thirteen species were obtained from the smaller streams, 77 per cent. from swift waters, and 82 per cent. from waters with a bottom of rock and sand. Only 12 per cent., in fact, came from lakes and ponds, and 18 per cent. from waters with a muddy bottom.

The Typical and the Non-typical Species.

A comparison, in respect to the strength of their local preferences, between the six species which, by means of an analy-

sis of their associative ratios, I have distinguished as typical and the six less typical species, shows that the more typical group occurs in the smaller rivers and creeks in 88 per cent. of these collections, and the less typical in 47 per cent.; the first group, in swift waters in 88 per cent. of the cases, and the second in 62 per cent.; the first, in rocky or sandy streams in 91 per cent., and the second in 66 per cent. That is, the frequency of occurrence of the less typical species in small rivers and creeks is 53 per cent. of that of the more typical species; in swift waters it is 71 per cent., and on rock and sandy bottoms it is 72 per cent.,—an average of 65 per cent. for these three factors. These purely ecological ratios agree in a significant manner with the corresponding averages to be drawn from the tables of associative frequencies, as may be seen by reference to Table I. If we average separately the totals for the first six and the last six species of that table, we find the average of the latter group to be 63 per cent. of that of the former—the difference in degree of associative affiliation is essentially the same as the difference of ecological relationship, the one conclusion confirming, and likewise explaining, the other.

It is further to be noticed, of the ecological affinity of the six selected species, that no one of them has been found in upland or glacial lakes; that their occurrence in lowland lakes, ponds, and sloughs—an average of only 1 per cent.—is so rare as to be negligible; and that, omitting *Ammocrypta pellucida*, which is in some respects peculiar, the frequency ratio for the larger rivers ranges from 3 to 9 per cent., with an average of only 5.5 per cent. for these species. This uniformity of their ecological relationships, which makes of them a well defined ecological group, is the explanation, of course, of their high degree of associative affiliation. The most notable specific differences among them are the relative frequency of *Ammocrypta pellucida*, and the absence of *Diplesion blennioides*, in my two hundred and ninety-three collections from the larger rivers.

The six less typical species, on the other hand, have little in common except their difference from this more typical group. *Boleosoma nigrum*, of which we have two hundred and

thirty-six collections, is an abundant and wide-ranging species, with comparatively feeble ecological preferences, as is shown by the fact that 15 per cent. of these collections are from lakes, 32 per cent. from still waters, and 11 per cent. from those with a muddy bottom. *Percina caprodes* (sixty collections) makes a similar showing, this being also a lake species in part (19 per cent.); but it differs from the preceding in the fact that it has occurred more frequently in the larger streams (10 per cent.), less frequently in still waters (7 per cent.), and not at all on muddy bottoms. *Cottogaster shumardi*, so far as may be judged from our sixteen lots of this species, is peculiar in its frequency in the larger rivers (55 per cent.) and the lowland lakes (18 per cent.), and in its avoidance of the smaller streams (only 4 per cent. in the creeks and smaller rivers). *Etheostoma jessiæ* (one hundred and fifty-eight collections) is an indifferent species, and occurs in almost equal ratios in large rivers, small rivers, creeks, and lowland lakes. *Boleichthys fusiformis*, which we have taken fifty-six times, is rare in the larger rivers, and seems to be the commonest of all our species in the upland lakes. *Boleosoma camurum* (one hundred and seven collections) is somewhat less indiscriminate in its local preferences. It is commonest in creeks (42 per cent.) and relatively rare in the larger rivers (9 per cent.). It apparently has no marked preference for swift waters over slow, nor for a hard bottom as compared with one of mud.

The ecological heterogeneity of these least typical species is reflected in their relatively feeble associative affiliations, these six species having a mutual associative ratio (derived from Table II.) of 1.4, while the corresponding ratio of the first six more typical species of Table II. is 3.28.

Association and Distribution.

The association of species may be looked upon as a consequence of their distribution. Species of wholly different general, or geographical, distribution can, of course, never be associated; and the same is true of those of wholly unlike local distribution. Those whose areas of general distribution merely

overlap, will be less frequently associated, other things being equal, than those whose distribution areas are identical; and species which are equally attracted to some local situations and unequally attracted to others, will be less frequently associated than those whose local preferences are altogether similar. Furthermore, if two species which occupy the same situations in the same area have a widely unlike abundance in different parts of this area—one being much the most abundant to the north, for example, and the other to the south—these species will occur together in collections less frequently, will have a lower coefficient of association, than if the two were most abundant in the same section and least abundant in the same. The number of joint occurrences will be conditioned, in part, in each section of the common area, by the abundance there of the less abundant species. It is impossible, consequently, to distinguish, by a simple inspection of a table of coefficients, local from general factors among the determining causes of difference in associative frequency. For this purpose maps of species distribution, and tables showing the locality preferences of species (like my Table VI.) must be studied in connection with tables of associative coefficients.

The causes controlling general distribution and local distribution are alike ecological, those affecting general distribution being usually general—climatic, topographic, hydrographic, and the like—and those affecting local distribution being local. In a small area like that of Illinois, one in which there are comparatively few physical barriers to the intermingling of fishes, these two classes of causes are not widely different, but they must nevertheless be distinguished, so far as possible, if we are to have a clear and correct knowledge of ecological relationships.

Comparative Study of Tables and Maps.

As an example of the manner in which these factors may be separated by a comparison of my tables and maps, and of the extent to which associate relationships may be accounted for, we may take a few instances of very low, and others of

very high, coefficients from Table II., and look up the facts concerning the species compared, as given in Table VI. and in the distribution maps appended to this paper. Thus far, it may be noticed, I have dealt with aggregates and average numbers only, which, owing to the heterogeneous and variable character of the data, are much more likely to be uniformly reliable than are the separate entries of the tables. The present discussion will, however, necessarily bring into comparison these separate entries, and the reasonableness and consistency of the conclusions reached by it may serve as some measure of the validity of their individual coefficients.

By reference to Table II. it will be seen that zeros appear at five points, in place of coefficients of association—an indication that representatives of the several pairs of species concerned have never been taken together by us in the same collection. This, as already pointed out, must mean either a complete difference in general distribution, so far as represented by my collections, or a very radical difference in locality preference.

Species 1443 and 1461 (*Diplesion blennioides* and *Etheostoma zonale*) are examples. A glance at the distribution maps of these species will show that each has been taken by us only in a different part of the state from the other, *blennioides* being confined to the Wabash valley, with the exception of a single collection at Chicago, and *zonale* being limited to the Illinois and Rock river systems. It seems difficult to believe that the flat and indefinite watershed separating the tributaries of the Wabash from those of the Illinois, can constitute a physical barrier sufficient to prevent the intermingling of these two species. On the other hand, it must be admitted that their ecological relations, as expressed in their preferences of situation, are, on the whole, very similar, as may be seen by a comparison of the two in Table VI.

A similar explanation is to be made in the case of *Diplesion blennioides* and *Cottogaster shumardi* (1443 and 1436). Here the areas of our collections of these two species are entirely separate, with the exception of a single collection of *Cottogaster* from the Wabash valley—to which *Diplesion* was entirely con-

fined. Furthermore, *Cottogaster* has been taken only in the larger streams or their immediate neighborhood, as is shown by the distribution map for that species; while *Diplesion* is limited to the smaller rivers and creeks.

With respect to *Cottogaster shumardi* and *Etheostoma cœruleum* (1436 and 1477), the case is a little less clear, and it is quite possible that with a larger number of collections containing the former species, the two might have been found in company. It is true that only 4 per cent. of our collections of *Etheostoma cœruleum* have come from the larger rivers and from stagnant waters to which *Cottogaster* is confined. On the other hand, a concurrence of the locality marks on the maps of distribution of these species (Maps V. and XII.) shows that the two were taken from the same locality—although not in the same collections—in three out of nine possible cases.

The lack of any coincident occurrence of *Cottogaster shumardi* and *Etheostoma zonale* (1436 and 1461) is explained by a glance at the maps (V. and X.), as due, not to a difference of geographical distribution, which is approximately identical for the two, but to that of local preference, the former species occurring only in or near the largest streams, and the latter being limited to the smaller rivers and creeks. Indeed, the two species were not taken by us from even the same locality at any time.

Nearly the same may be said of *Diplesion blennioides* and *Boleosoma camurum* (1443 and 1448), which have come from the same locality but once, although in general distribution they are not mutually exclusive. *Blennioides*, as may be seen from Table VI., is a species of more indefinite preferences than *camurum*, and occurs in various situations from which the latter is excluded.

I take up next five pairs of species, representatives of which have been occasionally taken together by us, but the coefficients of whose association are nevertheless very small.

Etheostoma zonale and *E. jessiæ* (1461 and 1474), for example, with an associative coefficient of only .37, show a pre-

ponderant abundance of the first in the north half of the state and of the second in central and southern Illinois. Among the twenty-nine localities from which the first of these species was taken, and the fifty-four for the second, there were but two in which both were found, and at each of these localities they occurred in only one collection. That is, in one hundred and eighty-eight separate collections of one or the other of these species from these various localities, the two were taken together but twice—a fact to be connected partly with the limitation of *Etheostoma zonale* to the northern half of the state, and partly with differences in the bodies of water in which these species habitually occur. Twenty-one per cent. of our collections of *jessiæ* came from the larger rivers, and only 3 per cent. of those of *zonale*; 19 per cent. of *jessiæ*, from the smaller rivers and creeks, and 74 per cent. of *zonale*; 24 per cent. of *jessiæ*, from lakes and ponds, and none of *zonale*.

Boleosoma camurum and *Etheostoma zonale* (1448 and 1461), whose coefficient of association is but .39, furnish an example of the relation of distribution already referred to, the area of the two species overlapping, but not coinciding throughout—that of *zonale* expanding to the northward and that of *camurum* to the southward. Partly in consequence of this fact, we have but a single joint occurrence of these species out of one hundred and thirty-eight collections containing one or the other. Their ecological relations, as shown by Table VI., are also quite unlike, *Boleosoma camurum* occurring in sluggish or stagnant waters five times as frequently as the other species, and in waters with a muddy bottom in a still greater differential ratio.

The low associative coefficient (.63) of *Hadropterus phoxocephalus* and *Boleichthys fusiformis* (1418 and 1494) is largely explained by the difference in preponderant distribution, the former being commonest in the Illinois valley and to the northward generally, while the latter is much the most abundant in the Wabash system and in extreme southern Illinois. In one hundred and thirty-eight collections containing one or the other of these species, they have occurred together but three times,—twice in branches of the Little Wabash River and

once in the Saline. The ecological relationships of the species are likewise very different, *phoxocephalus* showing a much stronger tendency than *fusiformis* to the larger streams. It occurs, for example, according to our data, in rivers in 63 per cent. of the cases, as against 13 per cent. for the other species. It also prefers swift to moderate water much more strongly, if I may judge from the small number of collections for which this factor was recorded, the ratios for swift water being 87 per cent. for *phoxocephalus* and 22 per cent. for *fusiformis*. A corresponding difference is seen in respect to the character of the bottom, 66 per cent. of our collections of *fusiformis* coming from waters with a muddy bottom and only 6 per cent. of those of *phoxocephalus*.

Boleosoma nigrum and *Etheostoma jessiæ* (1446 and 1474), with their coefficient of .99, may serve as an example of species similarly distributed but essentially indifferent as associates, a coefficient of 1, it will be remembered, indicating a neutral relation. A glance at the distribution maps of the species shows at once some notable differences. *Boleosoma nigrum*, the most abundant of our darters, and taken by us in two hundred and thirty-six collections, has virtually the same geographical distribution as the other species, but it is represented in the larger rivers in very much smaller ratio. The marks of local distribution for the more abundant species are widely and rather uniformly scattered over the map, with but few on the larger streams, while those of the less abundant species are strung, like beads, along the principal rivers of the state. On the other hand, neither species is definitely excluded from either the territory or the situations of the other, as may be seen by a comparison of the figures for them given in Table VI.

Turning now to pairs of species with extraordinarily high associative coefficients, I may call attention first to *Etheostoma zonale* and *Etheostoma cæruleum* (1461 and 1477), whose coefficient reaches the remarkable figure of 8.38. The general distribution of these species is substantially the same, except that *Etheostoma cæruleum* has a greater development to the south. *Etheostoma zonale* is much less numerous than *cæruleum*, but

both species have been found most frequently in the eastern part of the state. A close comparison of the distribution maps shows that both have been taken from eighteen of the thirty *localities* in which the less abundant one was found; and they have been taken together in seventeen of the one hundred and five *collections* containing either or both.

A comparison of their local preferences indicates a close agreement in ecological relationship. Each of the species was found in the larger rivers in 3 per cent. of the collections; *zonale* in 97 per cent. of those from the smaller rivers and creeks, and *cæruleum* in 89 per cent.—the remainder of the latter coming from lowland lakes and ponds (1 per cent.) and from various miscellaneous sources. Eighty-nine per cent. of the collections of *zonale* and 83 per cent. of those of *cæruleum* were from streams of swift or moderate flow; 89 per cent. of *zonale* and 92 per cent. of *cæruleum*, from rock and sandy bottom. The only notable difference between these species is the preponderant disposition of *zonale* towards the smaller rivers rather than the streams classed as creeks.

The next highest coefficient (5.69) is that of *Hadropterus phoxocephalus* and *Etheostoma zonale* (1418 and 1461), which have occurred together sixteen times in my one hundred and one collections of one or the other. Both have been taken from seventeen of the thirty localities in which we have found *zonale*. The general distribution of the two differs but little, except that *zonale* is very much less abundant than *phoxocephalus*, and has been limited much more closely to the Illinois and Rock river basins. The ecological ratios for *zonale* and *phoxocephalus* respectively are,—larger rivers, 3 per cent. and 7 per cent.; smaller rivers, 74 per cent. and 56 per cent.; creeks, 23 per cent. and 26 per cent.; lakes and ponds, 0 and 3 per cent. The ratios of preference for rapid and slow waters respectively are still more closely approximate—89 per cent. of *zonale* and 87 per cent. of *phoxocephalus* from moderate or rapid currents. The preferences of the two species for rock and sandy bottom are similarly close—89 per cent. for *zonale* and 94 per cent. for *phoxocephalus*.

The next coefficient in order of size, that of *Hadropterus phoxocephalus* and *Ammocrypta pellucida* (1418 and 1450), is 4.95. These species are virtually identical in general distribution, *pellucida* being, however, comparatively scarce. The two species have been taken in ten of the seventeen localities in which *pellucida* was found, and have occurred conjointly eight times in the ninety-six collections containing one or the other. In general ecological relationship they are very closely similar, both occurring infrequently in the larger rivers, and in smaller rivers more frequently than in creeks. *Ammocrypta pellucida* has not been taken at all in lakes and ponds, and *phoxocephalus* only to the amount of 3 per cent. Both are rapid-water species, and strongly prefer streams flowing over rock and sand to those with muddy bottoms.

Hadropterus aspro and *Ammocrypta pellucida* (1421 and 1450), with a coefficient of 3.97 based on their twelve joint occurrences in one hundred and sixty-six collections, were taken from the same localities in ten cases of a possible seventeen. *Ammocrypta pellucida*, although much the less abundant, is distributed in general precisely like *aspro*, except that it does not show so marked a preference as does the latter species for the eastern part of the state. With respect to the character of the streams in which these species are most generally found, the ratios are unusually similar, *pellucida* occurring, however, according to our data, more commonly in the larger rivers, and *aspro* more frequently in creeks. Neither has been taken by us in lakes or ponds. The ratios of preference for waters with a clean bottom are 84 per cent. for each.

Percina caprodes and *Etheostoma zonale* (1417 and 1461) were taken together four times in the eighty-eight collections containing either or both. Their associative coefficient is 3.55. Their general distribution is different in the fact that *caprodes* is the more abundant in the central and southeastern parts of the state. They were collected from the same localities seven times out of a possible thirty. In ecological relationships they are only fairly similar. Both occur in the larger rivers, but

Percina caprodes in the larger percentage. This species was likewise frequently found in lakes and ponds, from which *zonale* was entirely absent. Their relations to slow and rapid waters seem essentially the same, but while all the collections of *caprodes* were taken from sand and rock, 11 per cent. of those of *zonale* came from a muddy bottom.

Indeed, we have, for the first time, in these last two species, a pair whose ecological records do not seem to correspond quite closely to their associative coefficients—a fact which might be due to a number of collections of these species too small to give a reliable average, or to the influence of ecological factors not covered by the classification of Table VI. *Percina caprodes* was represented by sixty collections, and *Etheostoma zonale* by thirty-two; but I have information concerning the relations of the species to the water current for only fourteen collections of the first species and eighteen of the second, and concerning their relation to the kind of bottom for only twenty of the first and nineteen of the second. On the other hand, it seems certain that the local distribution of darters must be affected by many things not referred to in Table VI. —variations in the mere instinct of segregation, in the kind of food preferred, in relations to the temperature and the chemical condition of the water, and the time of the year at which the greater part of the collections were made—involving, as this may, similarities and differences of the annual migratory movements of the species—and several other like conditions.

Collections for Ecological Study.

It has been the object of this paper to test the availability and the usefulness for ecological study, of the data of the careful zoological collector, by applying to them a special method of classification and analysis. At the same time, of course, the method itself has been severely tested; and it might have failed completely in this instance without being permanently discredited.

The unit of this paper is the collection; but this term as here used is highly various in its meaning, and to some extent

accidental in its denotation. It usually includes everything which it was convenient or desirable to catalog under one accessions number, with a mention of the date, place, and body of water from which the collection came, and, in the majority of cases, particulars concerning the apparatus used and the more notable features of the situation. It may cover at one time the product of a single haul of a small minnow seine from a rivulet or a pond, and at another time that of a number of longer hauls with a larger seine from a great lake or from a considerable stretch of the course of a great river; and in this discussion no account has been taken of differences of condition, season, or time of day, represented by the several accessions numbers.

If each collection had been made as much like every other as practicable in respect to the apparatus used, the proportionate area covered, and the definiteness and distinctness of the unit of environment from which it was drawn; if these ecological situations had been skilfully chosen, fully described, and thoroughly "sampled" as to the contents in fishes; and if collections, of moderate size but ample in number for the territory covered, had been judiciously repeated for each situation at different seasons and under varying conditions,—we should doubtless have obtained for our tables coefficients capable of yielding a larger and more complex knowledge than I have here presented of the local distribution of fishes under the influence of their environment.

In a later paper, in course of preparation, the writer intends to discuss, in a similar manner, the local and ecological relations of all the species obtained from a limited area—that of the Wabash valley in Illinois.

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EXPLANATION OF TABLES AND MAPS.

In place of the names of species, the corresponding numbers of Jordan and Evermann's "Synopsis of North American Fishes" have been used in the construction of the tables, as follows:—

1417. *Percina caprodes* (Raf.).
1418. *Hadropterus phoxocephalus* (Nelson).
1421. *Hadropterus aspro* (Cope & Jordan).
1436. *Cottogaster shumardi* (Gir.).
1443. *Diplesion blennioides* (Raf.).
1446. *Boleosoma nigrum* (Raf.).
1448. *Boleosoma camurum* Forbes.
1450. *Ammocrypta pellucida* (Baird).
1461. *Etheostoma zonale* (Cope).
1474. *Etheostoma jessiæ* (Jordan & Brayton).
1477. *Etheostoma cœruleum* Storer.
1490. *Etheostoma flabellare* Raf.
1494. *Boleichthys fusiformis* (Gir.).

Table I. shows, under each species number, first, the number of collections of the species used in this study; second, the coefficients of the association of the species with each of the others of the group of thirteen represented by this table, these coefficients being arranged in order of magnitude from above downward; and, third, the totals and the averages for each column. The species columns are arranged in the order of their average coefficients. At the bottom of the table is the sum of the totals for the species and the general average of their average coefficients, the last being the general associative coefficient for the entire group.

In Table II. the species numbers are placed in like order at the top and at the side of the table, and the coefficient of any two species will be found at the point of intersection of the column for one with the line for the other. The upper right half of this table is the reversed duplicate of the lower left half, inserted for convenience in following a series of coefficients.

Table III. is constructed like Table II., but with totals and averages added, as in Table I. It contains the coefficients of mutual association of the last three species of Table I., which are distinguished by the lowest average coefficients of the whole series of thirteen.

Table IV. is constructed like Table III. It contains the coefficients of mutual association of the "typical darters"—the first six of Table I. distinguished by their high average coefficients.

Table V. contains the coefficients of mutual association of the seven species which have occurred least frequently in my collections.

Table VI. is intended to represent the relations of preference and avoidance of the various species with reference to kinds of bodies of water, to current movements, and to character of bottom, so far as these are determinable from our data. Where the ratios do not amount to 100 per cent., the difference is due to the omission of miscellaneous minor data.

The general map of the distribution of collections (Map I.) shows, by the location of the red spots, all the localities from which collections of fishes have been made by us in the work of the Natural History Survey. The distribution maps for the various species indicate in the same way all the localities from which representatives of the species have been taken. *For an accurate idea of the significance of these species maps, each should be compared with Map I.*

The following numbered list of the counties of the state corresponds to the numbers on these maps.

1.	Jo Daviess.	35.	Hancock.	69.	Madison.
2.	Stephenson.	36.	McDonough.	70.	Bond.
3.	Winnebago.	37.	Fulton.	71.	Fayette.
4.	Boone.	38.	Mason.	72.	Effingham.
5.	McHenry.	39.	Tazewell.	73.	Jasper.
6.	Lake.	40.	McLean.	74.	Crawford.
7.	Cook.	41.	Vermilion.	75.	Lawrence.
8.	Du Page.	42.	Champaign.	76.	Richland.
9.	Kane.	43.	Piatt.	77.	Clay.
10.	DeKalb.	44.	Dewitt.	78.	Marion.
11.	Ogle.	45.	Logan.	79.	Clinton.
12.	Lee.	46.	Menard.	80.	St. Clair.
13.	Carroll.	47.	Cass.	81.	Monroe.
14.	Whiteside.	48.	Schuyler.	82.	Randolph.
15.	Rock Island.	49.	Brown.	83.	Washington.
16.	Mercer.	50.	Adams.	84.	Perry.
17.	Henry.	51.	Pike.	85.	Jefferson.
18.	Bureau.	52.	Scott.	86	Wayne.
19.	Putnam.	53.	Morgan.	87.	Edwards.
20.	La Salle.	54.	Sangamon.	88.	Wabash.
21.	Kendall.	55.	Christian.	89.	White.
22.	Grundy.	56.	Macon.	90.	Hamilton.
23.	Will.	57.	Moultrie.	91.	Franklin.
24.	Kankakee.	58.	Douglas.	92.	Jackson.
25.	Iroquois.	59.	Edgar.	93.	Williamson.
26.	Ford.	60.	Clark.	94.	Saline.
27.	Livingston.	61.	Coles.	95.	Gallatin.
28.	Marshall.	62.	Cumberland.	96.	Hardin.
29.	Woodford.	63.	Shelby.	97.	Pope.
30.	Stark.	64.	Montgomery.	98.	Johnson.
31.	Peoria.	65.	Macoupin.	99.	Union.
32.	Knox.	66.	Greene.	100.	Alexander.
33.	Warren.	67.	Calhoun.	101.	Pulaski.
34.	Henderson.	68.	Jersey.	102.	Massac.

TABLE I.—ASSOCIATIVE COEFFICIENTS OF THIRTEEN SPECIES OF DARTERS (ETHEOSTOMINÆ).

In order of size.

Species Numbers	1418	1461	1490	1421	1450	1477	1417	1446	1436	1443	1474	1448	1494
Collections	85	32	30	159	19	90	60	236	16	24	158	107	56
	5.69	8.38	4.44	3.97	4.51	8.38	3.55	3.25	4.17	3.48	2.77	3.34	3.34
	4.95	5.69	4.17	3.97	3.97	4.44	3.33	3.20	3.28	2.57	2.76	2.34	1.80
	3.33	3.97	3.80	3.20	3.28	2.73	3.13	2.90	3.13	2.45	1.89	1.89	1.57
	2.96	3.80	3.48	2.96	2.90	2.45	2.63	2.62	2.94	2.36	1.84	1.87	1.56
	2.94	3.55	3.25	2.73	2.63	2.36	2.45	2.45	2.77	2.14	1.69	1.32	1.52
	2.76	2.62	2.73	2.73	2.34	2.34	2.20	2.14	2.34	1.84	1.33	1.29	1.12
	2.57	1.56	1.80	2.20	2.14	1.83	1.87	1.69	1.57	1.77	1.27	.91	.99
	2.14	1.39	1.75	1.77	1.75	1.30	1.69	1.63	1.12	1.63	1.27	.62	.94
	1.83	.39	1.27	1.57	1.39	.99	1.69	1.52	.79	.24	.99	.50	.68
	1.32	.37	1.17	1.57	1.33	.77	1.30	.99	0.0	0.0	.77	.39	.63
	1.17	0.0	1.11	1.29	.94	.31	1.11	.91	0.0	0.0	.68	.31	.30
	.63	0.0	.62	1.27	.50	0.0	.30	.79	0.0	0.0	.37	0.0	.24
Totals	32.29	31.72	29.59	29.23	28.12	27.90	25.25	24.07	22.11	18.48	17.63	14.78	14.69
Averages	2.69	2.64	2.46	2.44	2.34	2.32	2.10	2.01	1.84	1.54	1.47	1.23	1.22
Probable Errors	± .28	± .43	± .25	± .18	± .24	± .26	± .15	± .16	± .20	± .16	± .14	± .16	± .16
Ratio of Prob. Errors to Averages	.104	.163	.101	.074	.103	.11	.071	.08	.109	.104	.097	.13	.131

Grand Total, 315.81. General Average, 2.02. (± .09)

Table II.—Associative Coefficients of Thirteen Species of Darters (Etheostominæ).

In the order of the size of the coefficients of association of each species with *Hadropterus aspro* (1421).

Sp.	Collections	1421	1450	1461	1446	1418	1490	1477	1417	1443	1436	1494	1448	1474
1421	159		3.97	3.97	3.20	2.96	2.73	2.73	2.20	1.77	1.57	1.57	1.29	1.27
1450	19	3.97		1.39	2.90	4.95	1.75	2.34	2.63	2.14	3.28	.94	.50	1.33
1461	32	3.97	1.39		2.62	5.69	3.80	8.38	3.55	0.0	0.0	1.56	.39	.37
1446	236	3.20	2.90	2.62		2.14	3.25	2.45	1.69	1.63	.79	1.52	.91	.99
1418	85	2.96	4.95	5.69	2.14		1.17	1.83	3.33	2.57	2.94	.63	1.32	2.76
1490	30	2.73	1.75	3.80	3.25	1.17		4.44	1.11	3.48	4.17	1.80	.62	1.27
1477	90	2.73	2.34	8.38	2.45	1.83	4.44		1.30	2.36	0.0	.99	.31	.77
1417	60	2.20	2.63	3.55	1.69	3.33	1.11	1.30		2.45	3.13	.30	1.87	1.69
1443	24	1.77	2.14	0.0	1.63	2.57	3.48	2.36	2.45		0.0	.24	0.0	1.84
1436	16	1.57	3.28	0.0	.79	2.94	4.17	0.0	3.13	0.0		1.12	2.34	2.77
1494	56	1.57	.94	1.56	1.52	.63	1.80	.99	.30	.24	1.12		3.34	.68
1448	107	1.29	.50	.39	.91	1.32	.62	.31	1.87	0.0	2.34	3.34		1.89
1474	158	1.27	1.33	.37	.99	2.76	1.27	.77	1.69	1.84	2.77	.68	1.89	

Table III.— Coefficient Table of the Four least frequent Associates.

Species	1443	1448	1474	1494
1443		0.0	1.84	.24
1448	0.0		1.89	3.34
1474	1.84	1.89		.68
1494	.24	3.34	.68	
Totals	2.08	5.23	4.41	4.26

General Average, 1.33

Table IV.— Coefficient Table of the Six most frequent Associates.

Species	1418	1461	1490	1421	1450	1477
1418		5.69	1.17	2.96	4.95	1.83
1461	5.69		3.80	3.97	1.39	8.38
1490	1.17	3.80		2.73	1.75	4.44
1421	2.96	3.97	2.73		3.97	2.73
1450	4.95	1.39	1.75	3.97		2.34
1477	1.83	8.38	4.44	2.73	2.34	
Totals	16.60	23.23	13.89	16.36	14.40	19.72

General Average, 3.47.

Table V.— Coefficient Table of the Seven least frequent Darters.

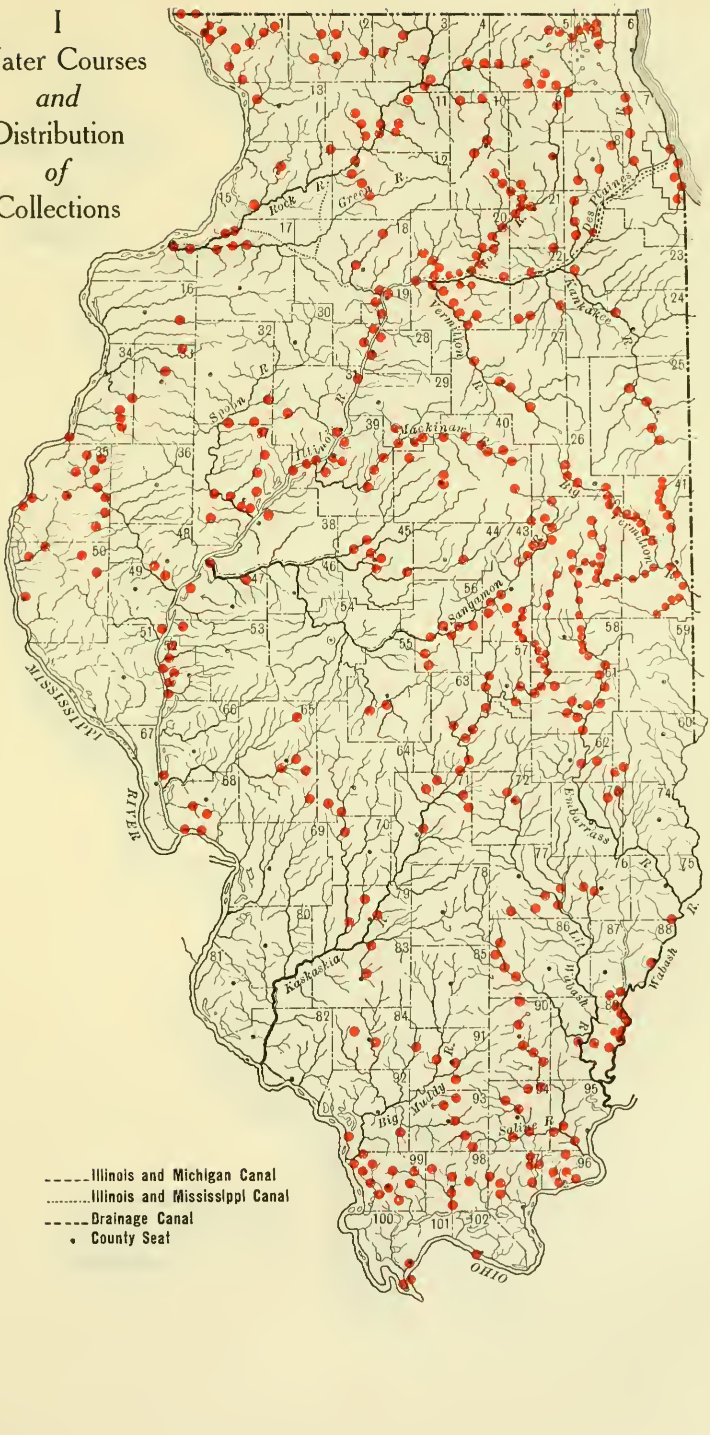
Species	1436	1450	1443	1490	1461	1494	1417
Collections	16	19	24	30	32	56	60
1436		3.28	0.0	4.17	0.0	1.12	3.13
1450	3.28		2.14	1.75	1.39	.94	2.63
1443	0.0	2.14		3.48	0.0	.24	2.45
1490	4.17	1.75	3.48		3.80	1.80	1.11
1461	0.0	1.39	0.0	3.80		1.56	3.55
1494	1.12	.94	.24	1.80	1.56		.30
1417	3.13	2.63	2.45	1.11	3.55	.30	
Totals	11.70	12.13	8.31	16.11	10.30	5.96	13.17

General Average, 1.85.

Table VI.—Local Preferences of Darters.

Situations	1450	1443	1490	1418	1421	1461	1477	1446	1417	1436	1474	1494	1448	Av.
Larger rivers	.14	.00	.09	.07	.06	.03	.03	.03	.10	.55	.21	.01	.09	.11
Smaller rivers	.47	.47	.00	.56	.42	.74	.44	.25	.37	.00	.19	.12	.23	.33
Creeks	.39	.53	.87	.26	.47	.23	.45	.53	.27	.04	.16	.25	.42	.37
Lowland lakes, ponds, sloughs, etc.	.00	.00	.04	.03	.01	.00	.01	.01	.10	.18	.24	.02	.17	.06
Upland lakes, ponds, etc.	.00	.00	.00	.00	.00	.00	.00	.14	.09	.00	.00	.60	.00	.06
Moderate to rapid current	1.00	.83	1.00	.87	.69	.89	.83	.68	.93		.83	.22	.44	.77
Sluggish to stagnant	.00	.17	.00	.13	.31	.11	.17	.32	.07		.17	.78	.56	.23
Muddy bottom	.16	.00	.00	.06	.16	.11	.08	.11	.00		.23	.66	.62	.18
Rocky and sandy bottom	.84	1.00	1.00	.94	.84	.89	.92	.89	1.00		.77	.34	.38	.82

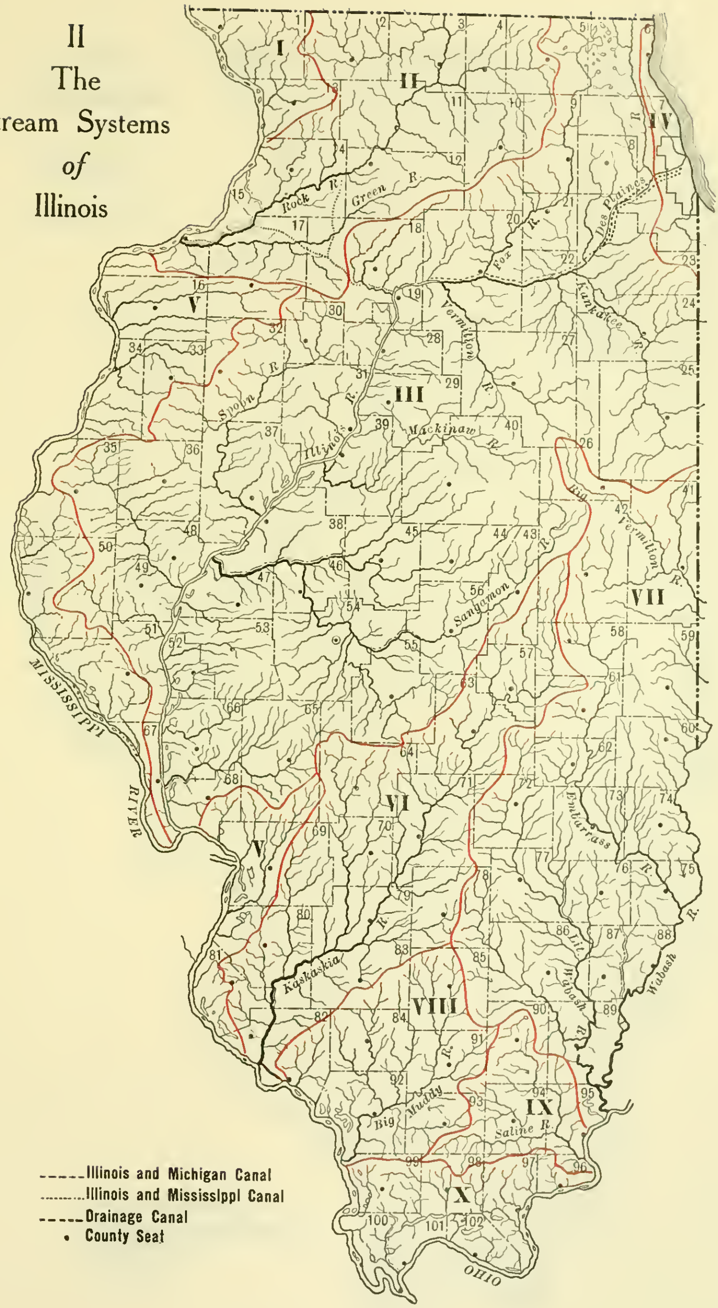
I
Water Courses *and* Distribution *of* Collections



-----Illinois and Michigan Canal
..........Illinois and Mississippi Canal
-----Drainage Canal
• County Seat

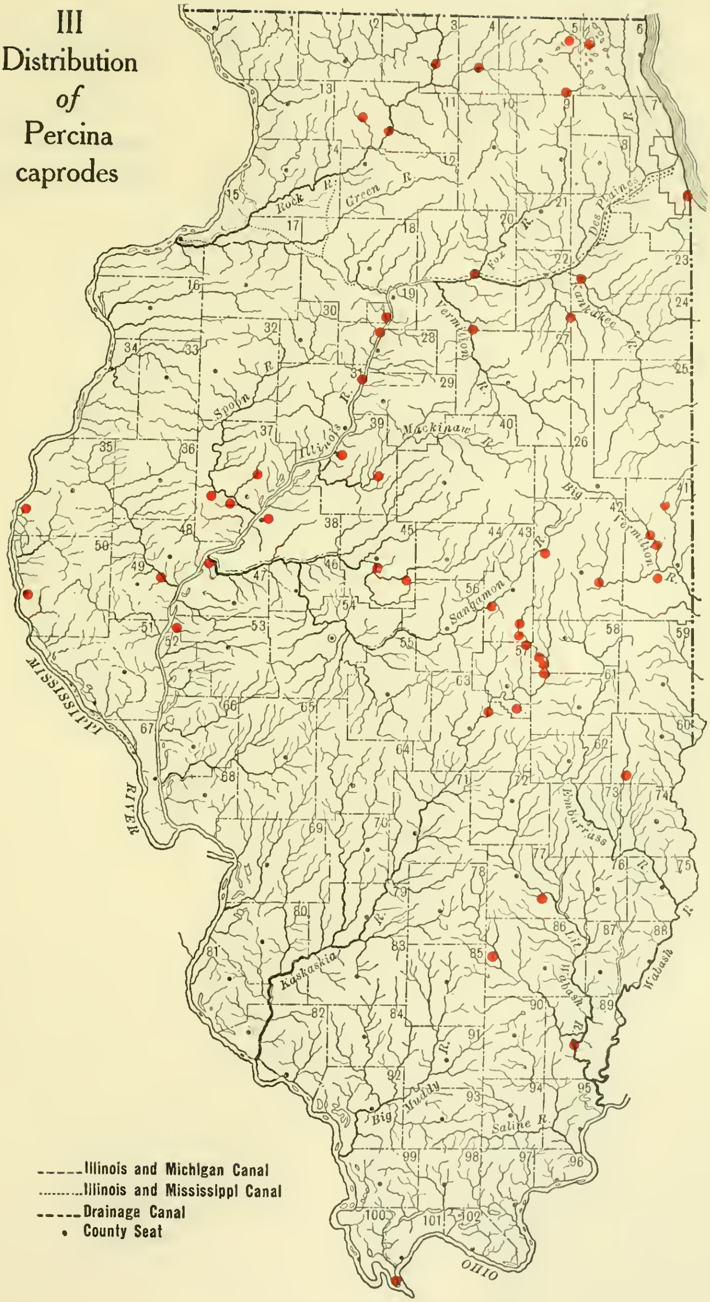
II

The Stream Systems *of* Illinois

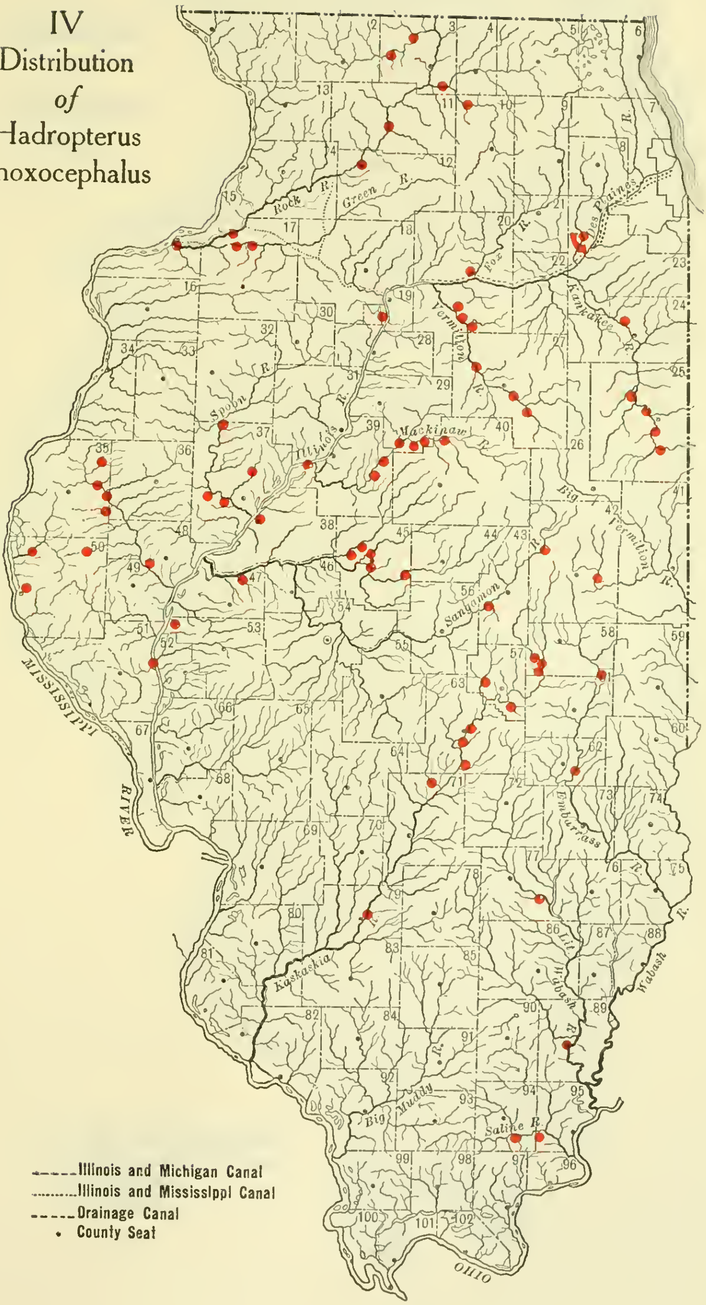


-----Illinois and Michigan Canal
..........Illinois and Mississippi Canal
-----Drainage Canal
• County Seat

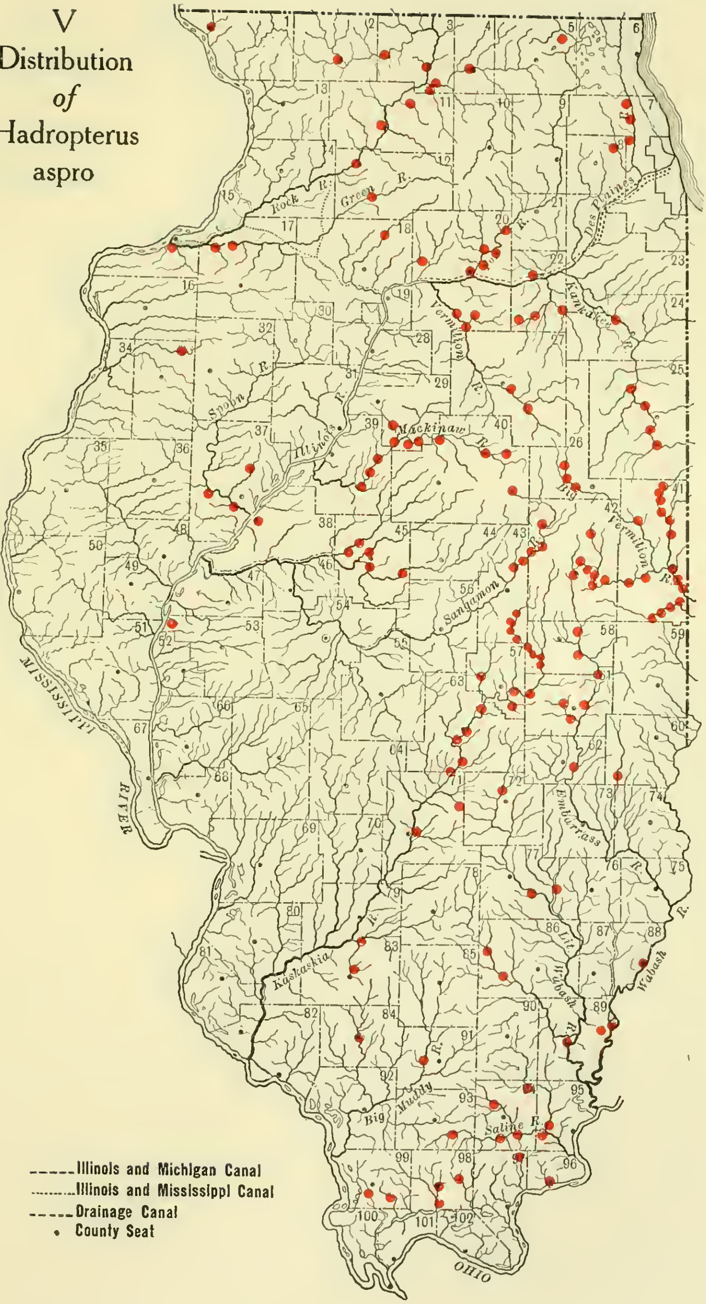
III
Distribution
of
Percina
caprodes



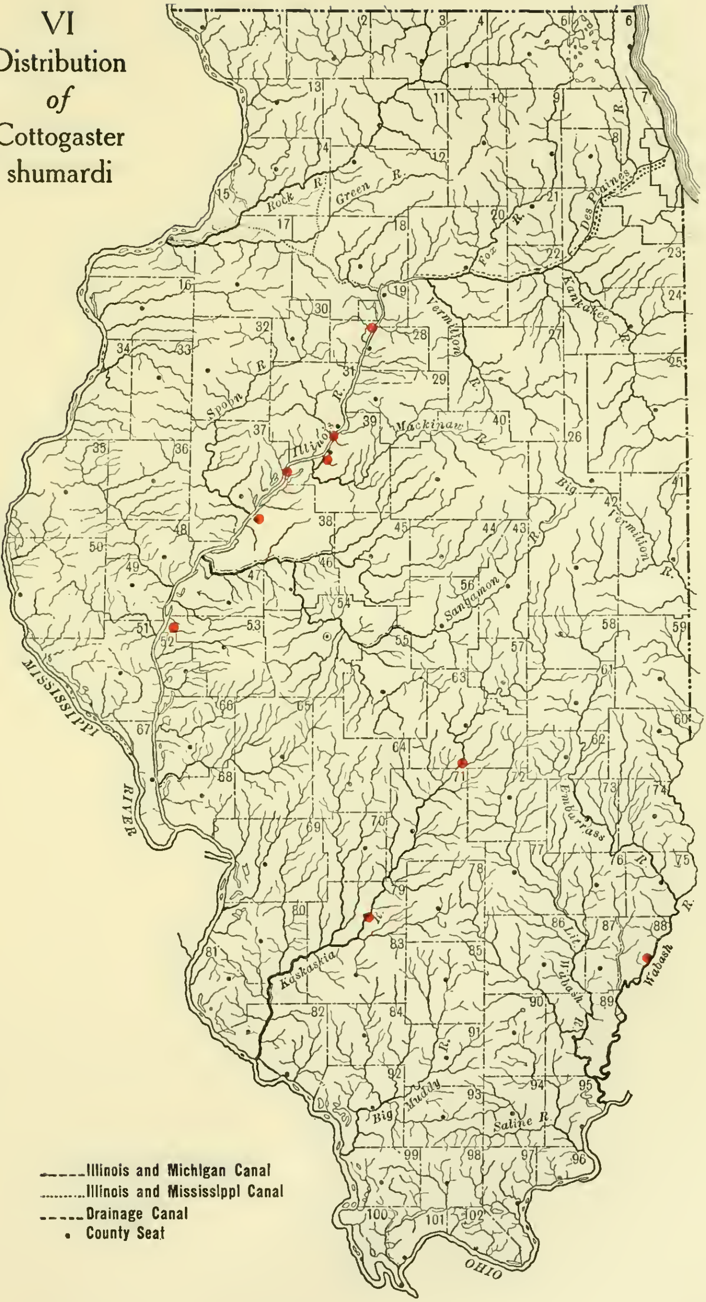
IV
Distribution *of* Hadropterus phoxocephalus



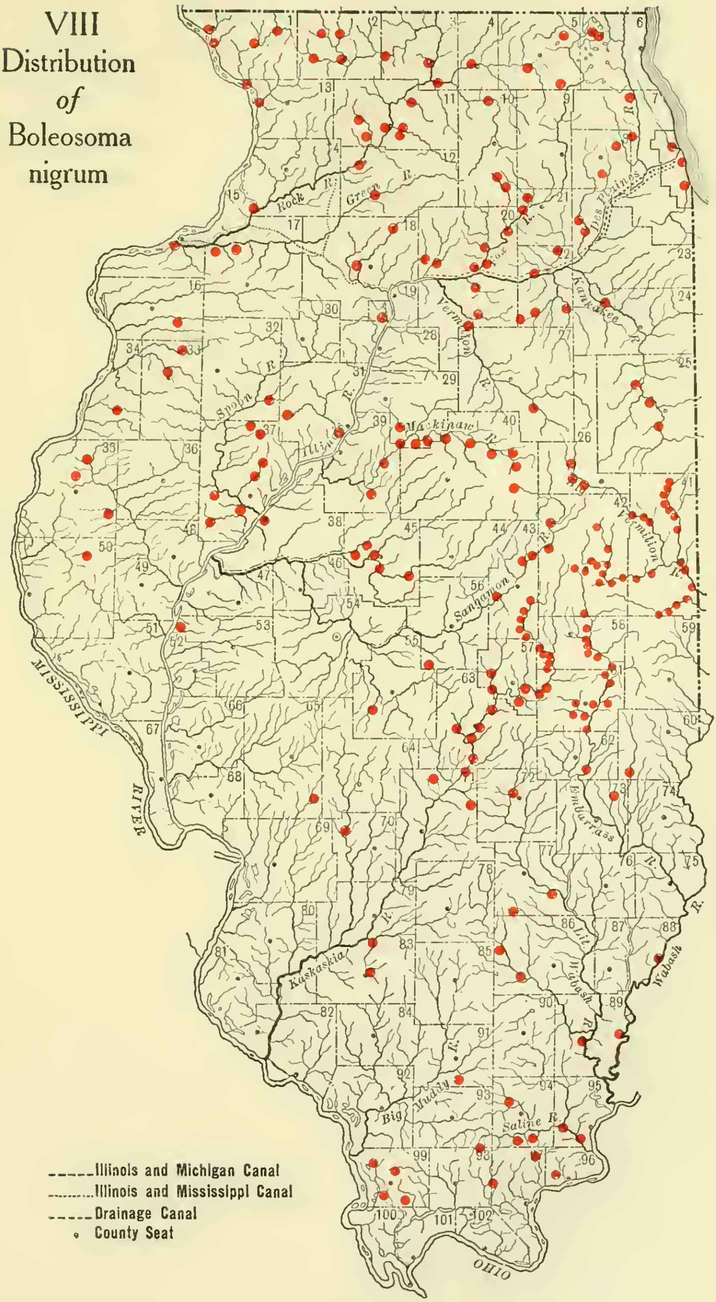
V
Distribution *of* Hadropterus aspro



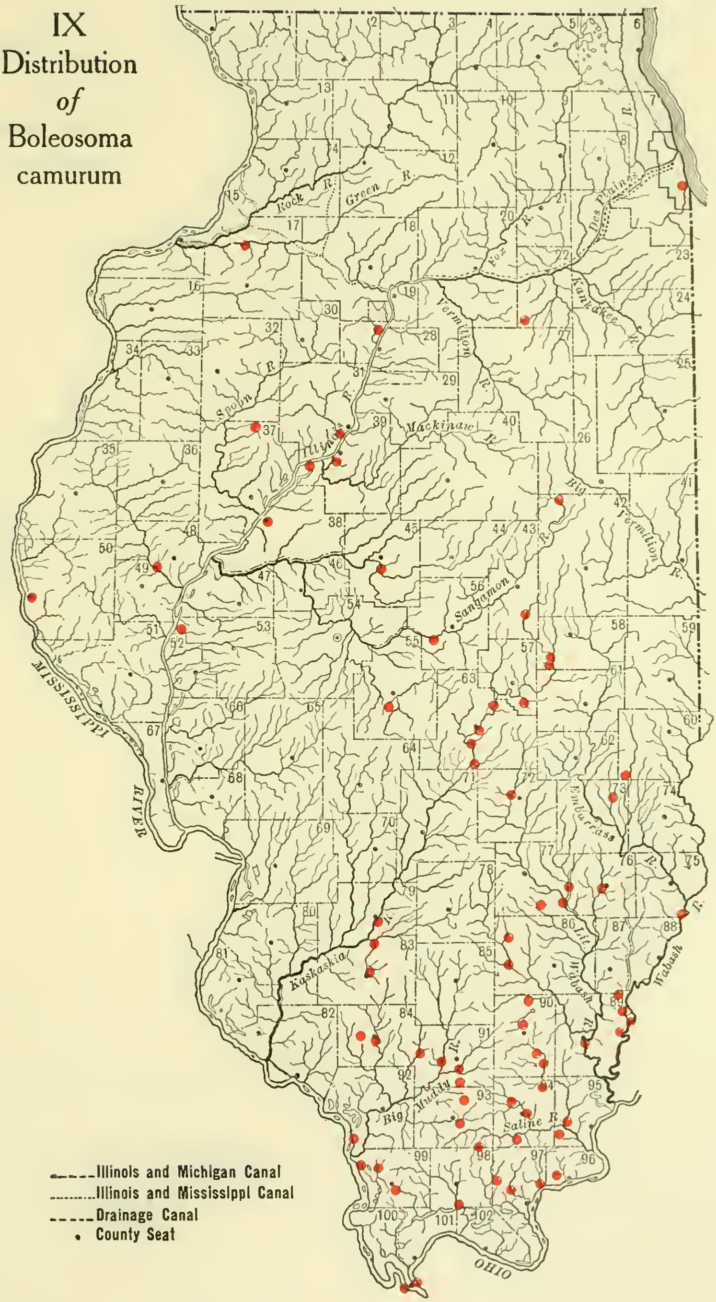
VI
Distribution
of
Cottogaster
shumardi



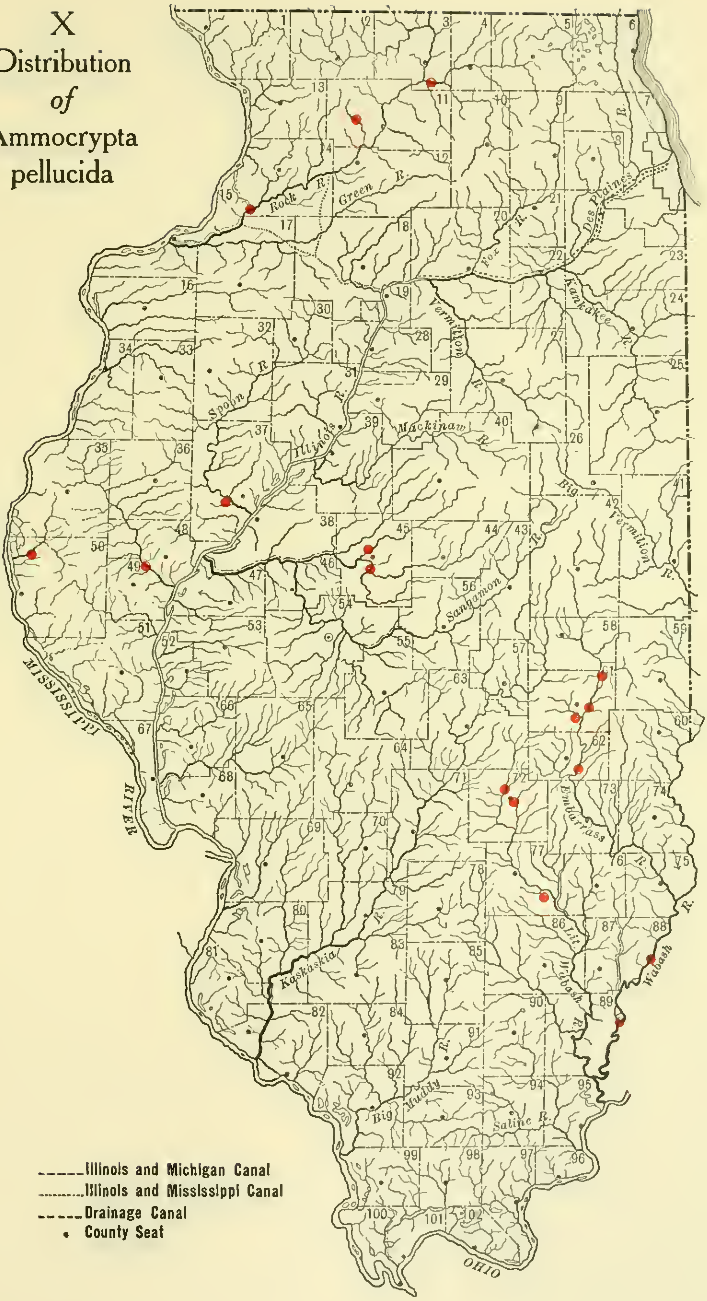
VIII
Distribution
of
Boleosoma
nigrum



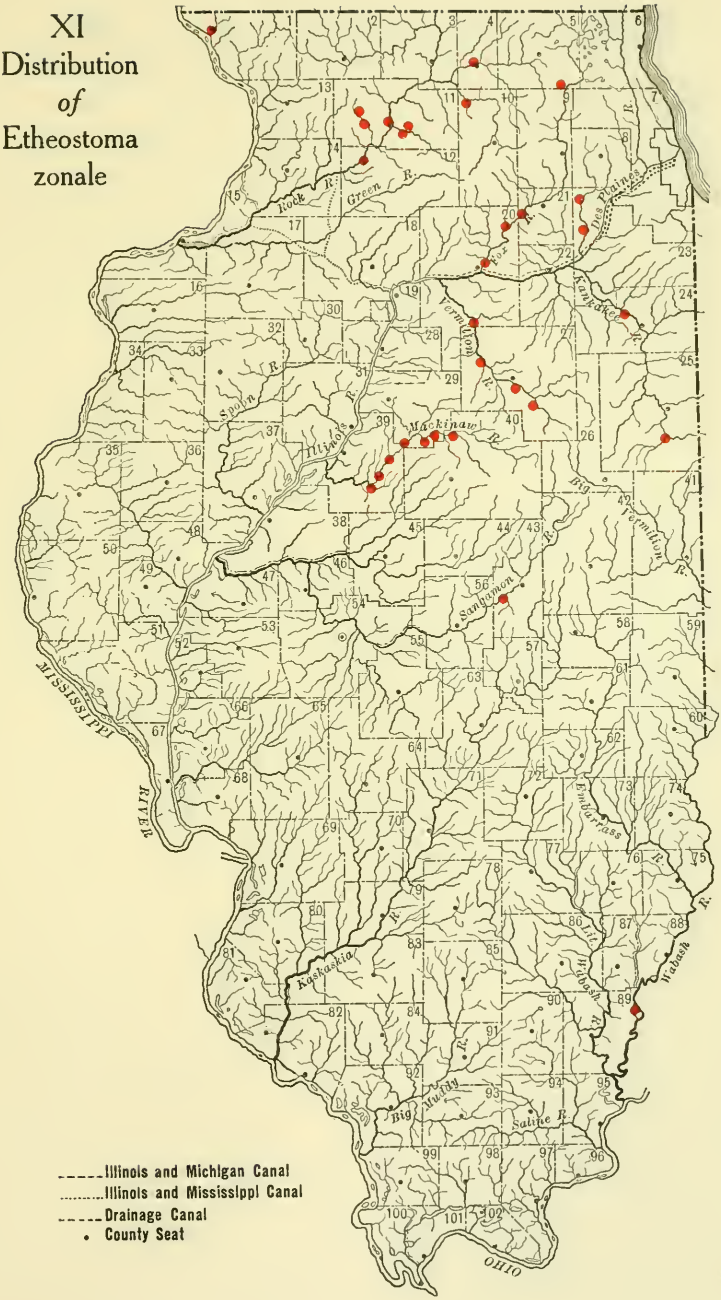
IX
Distribution
of
Boleosoma
camurum



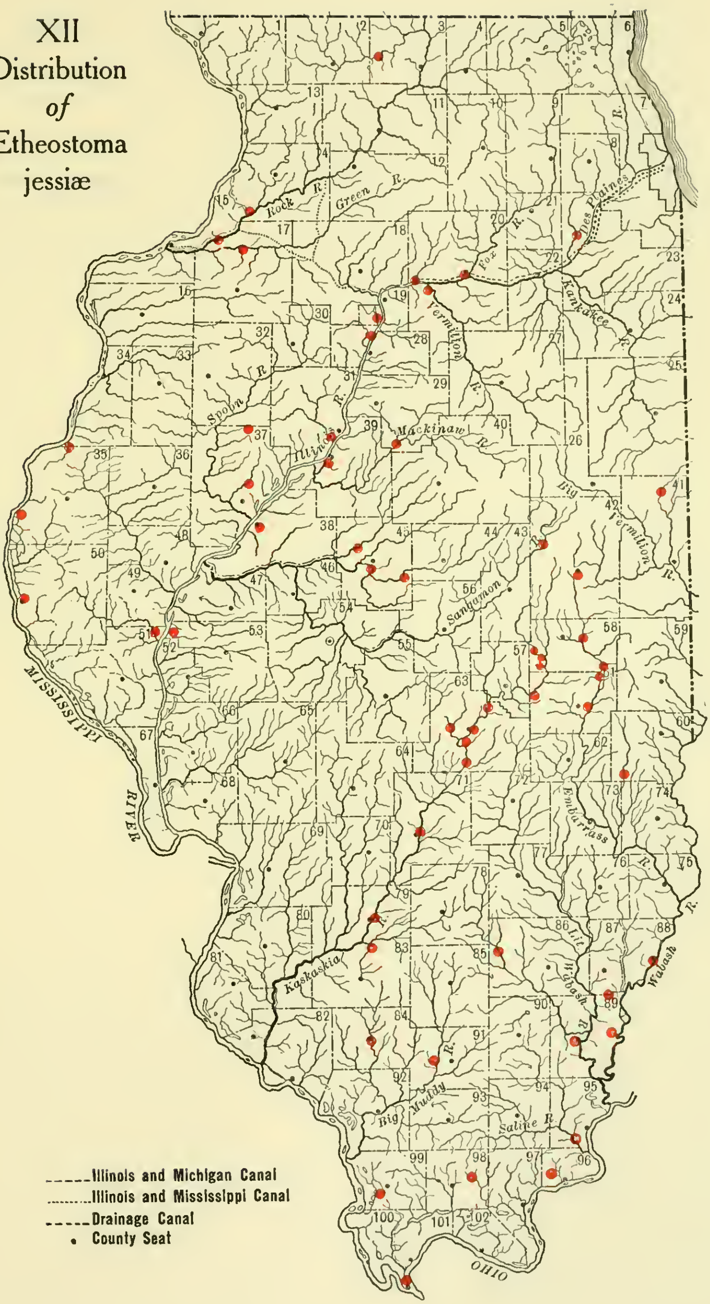
X
Distribution *of* Ammocrypta pellucida



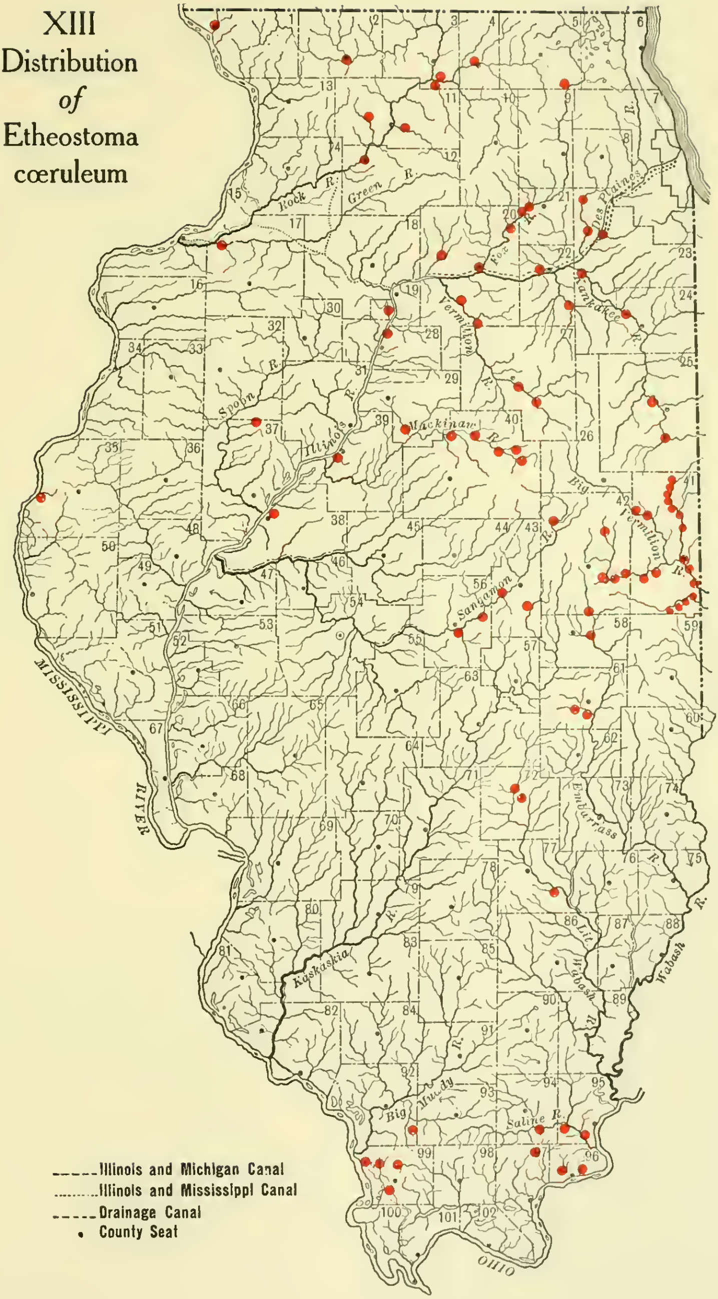
XI
Distribution
of
Etheostoma
zonale



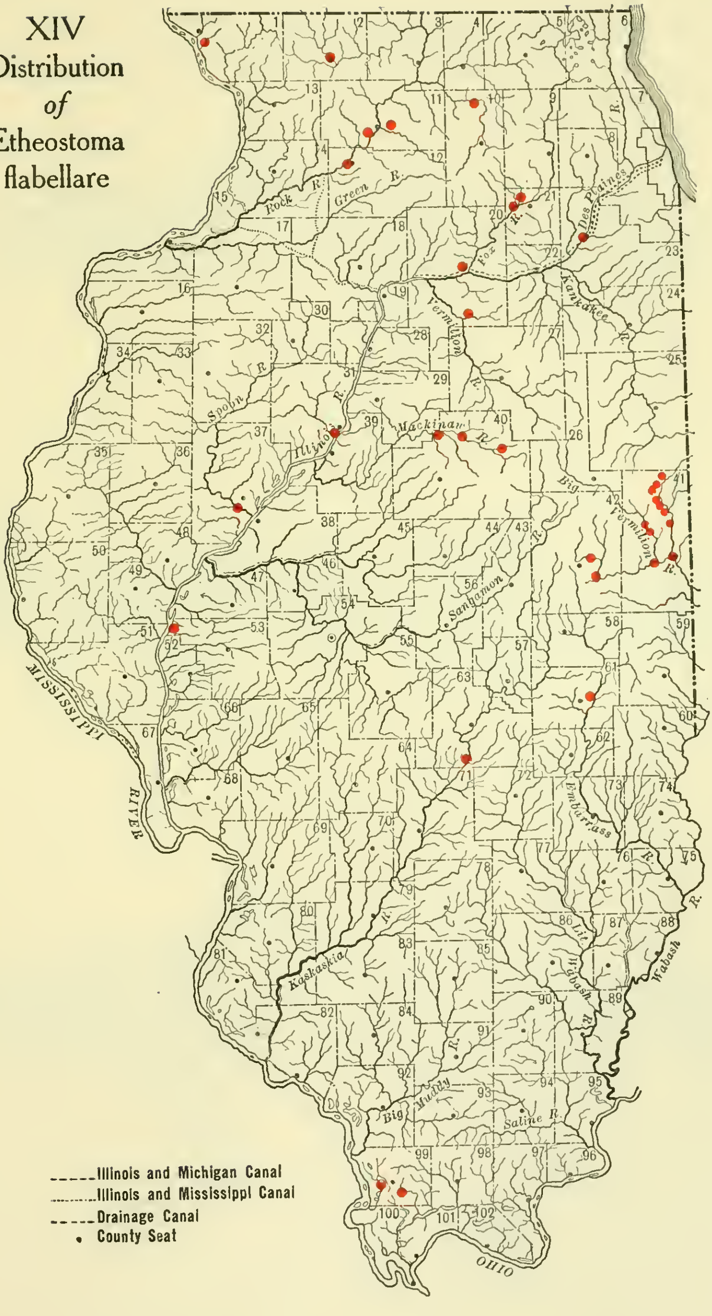
XII
Distribution
of
Etheostoma
jessiæ



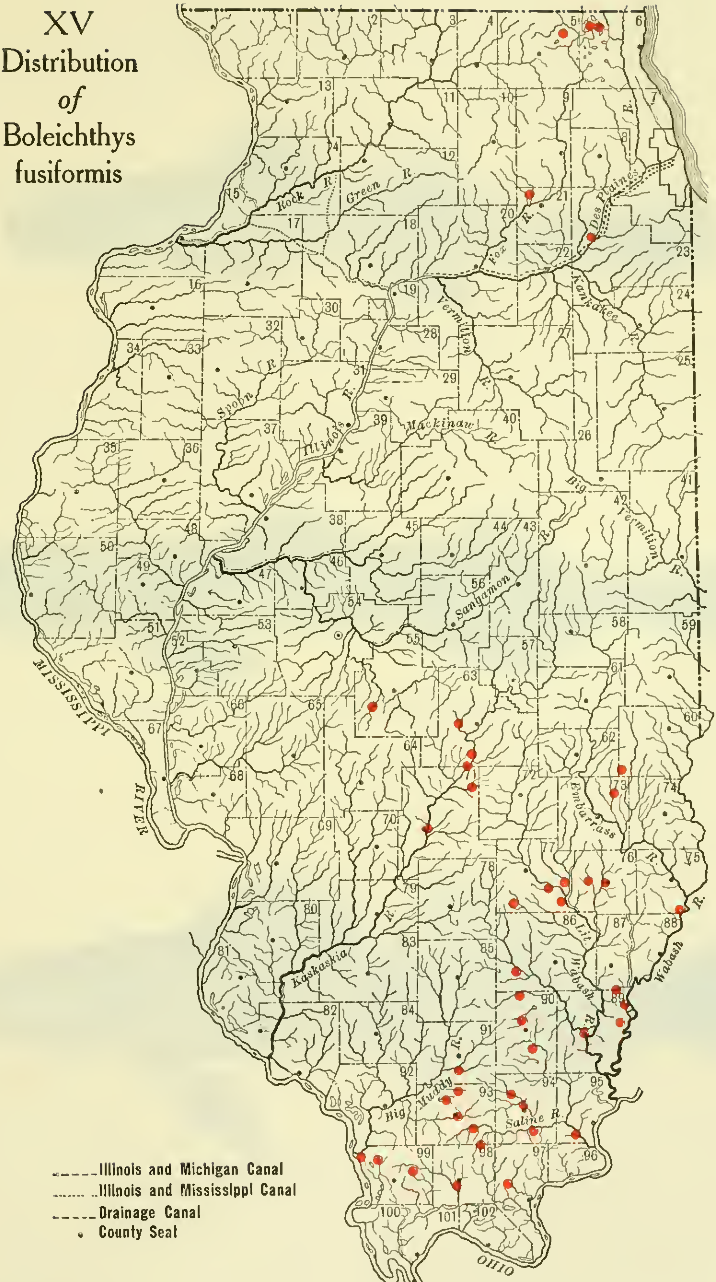
XIII
Distribution
of
Etheostoma
cœruleum



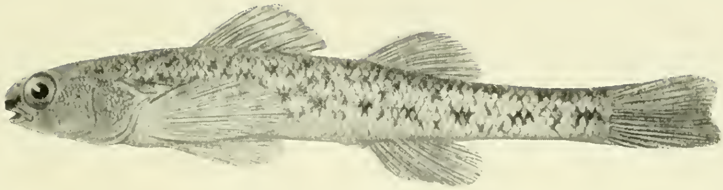
XIV
Distribution *of* Etheostoma flabellare



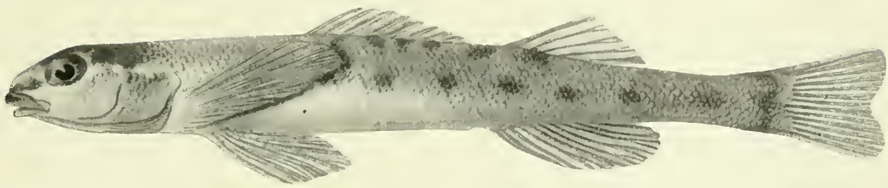
XV
Distribution
of
Boleichthys
fusiformis



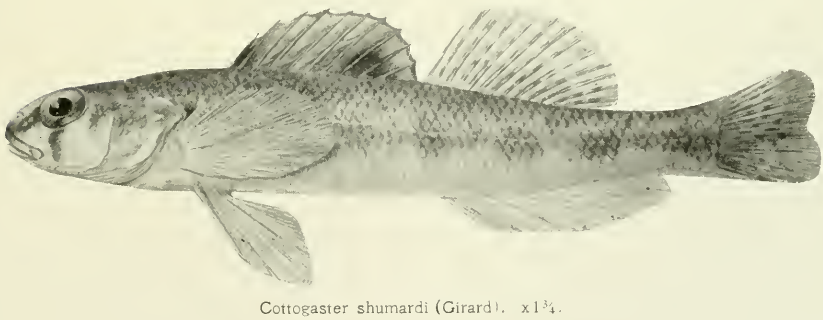
XXIV.



Boleosoma camurum Forbes. x2.

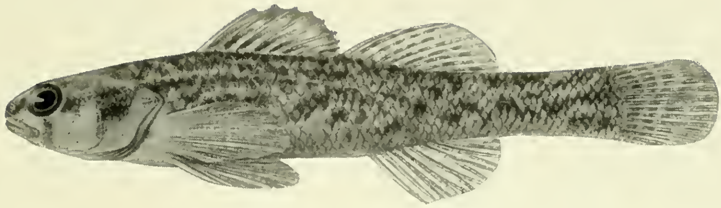


SAND DARTER. Ammocrypta pellucida (Baird). x $1\frac{2}{3}$.

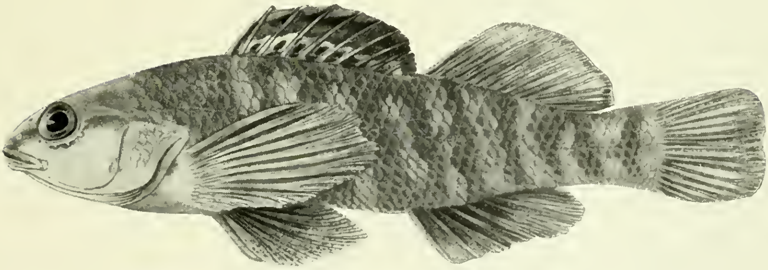


Cottogaster shumardi (Girard). x $1\frac{3}{4}$.

XXV.



Boleichthys fusiformis (Girard). x2.



RAINBOW DARTER. Etheostoma cœruleum Storer. Male. x 1¾

BANDED DARTER. Etheostoma zonale (Cope). Male. x 1¾

XXVI.

GIANT DARTER. *Percina caprodes* (Rafinesque). X$\frac{3}{4}$.

XXVII.

NELSON'S DARTER. Hadropterus phoxocephalus (Nelson). X1½.

XXVIII.

BLACK-SIDED DARTER. Hadropterus aspro (Cope & Jordan). X1¼.

XXIX.

GREEN-SIDED DARTER. Diplesion blennioides (Rafinesque). Natural size.

XXX.

JOHNNY DARTER, Male. Boleosoma nigrum (Rafinesque). X1⅔.

XXXI.

Etheostoma jessiæ (Jordan & Brayton). X2.

XXXII.

FAN-TAILED DARTER. Etheostoma flabellare Rafinesque. X1⅓.

BULLETIN

OF THE

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OF

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AN ORNITHOLOGICAL CROSS-SECTION OF ILLINOIS IN AUTUMN

BY

S. A. FORBES, PH.D.

SECOND EDITION, 1914

Article IX.—*An Ornithological Cross-section of Illinois in Autumn.* By S. A. Forbes.

The subject of the relations of interaction between organisms and their environment, animate and inanimate, which goes by the name of ecology, may be studied with reference to the welfare of species or to that of the general assemblage of organisms to which the species belong. The ecology of a species is special ecology; that of the assemblage is a phase or division of general ecology—more or less general according to the size and contents of the assemblage considered. In special ecology every ecological factor, every feature of the environment, is valued according to its importance to the species; in general ecology the various ecological factors are valued according to their significance in the general system of life. In special ecology the species is the all-important, dominating center; in general ecology each species takes its appropriate place—dominant, important, subordinate, or insignificant—according to its dynamic value as a part of the whole.

Precise studies in animal ecology have heretofore been made mainly in the special field, necessarily so in the beginning since a knowledge of the ecology of species must precede that of groups or assemblages of species. These special studies are, however, merely preliminary to a general study of the dynamic system of organic life as exhibited in its larger and more complex units. Without the corrective and organizing influence of such a study of the system as a whole, our ideas of that system must be badly proportioned and correspondingly inadequate or misleading—a fact readily illustrated by the state of our knowledge and opinion respecting the ecological significance of birds.

To learn what we now know of the effects of the activities of birds has required much difficult, expert, time-consuming study, especially of the details of their food, since it is mainly through the food relation that birds affect the welfare of other animals and of plants. These studies, although both qualitative and quantitative as related to the welfare of the various species of birds themselves, have been qualitative only as concerning the relation of birds to the general welfare; and we have little but vague estimate and doubtful surmise in place of a definite knowledge of the relative ecological values of the various

species, and equally little knowledge, in consequence, of the total significance of birds as a class. We do know fairly well (owing, in part, to the early work of this Laboratory*, but mainly to that of the United States Biological Survey) the principal features of the food of many species of our common birds, but we can not lay these data together for an intelligent estimate of the total effect of the life of birds on their environment except on the supposition that the various species are about equally abundant wherever they occur. That this is not the fact is obvious to every one, and it must be equally obvious, consequently, that until we know how abundant, on an average, the various species are in the various parts of the country and throughout the country at large, we can make little definite application, either scientific or strictly practical, of the knowledge we now have. Our present information in this field is like a chain, one of the links of which is missing and has been replaced by a piece of twine. To substitute iron for cotton at this point is the object of the studies now in progress in Illinois on the local distribution, average numbers, and ecological preferences of the various species of Illinois birds.

The Field Method.

To this end, after a preliminary quantitative study made in 1905-06 of the bird life of a single limited tract—a 400-acre stock and grain farm in central Illinois—a systematic program of field observation and statistical record was entered upon last August, with complete arrangements for its continuance through one entire year. Two acute and thoroughly reliable ornithological observers—one of whom, Mr. A. O. Gross, although still an undergraduate student in the University of Illinois, has had several years' experience as a collector and observer of birds—were sent into the field under instructions to traverse the state in various directions, traveling always in straight lines and always thirty yards apart, and noting and recording the species, numbers, and exact situation of all birds flushed by them on a strip fifty yards in width, including also those crossing this strip within one hundred yards to their front. No attention is paid by them, for this purpose, to any other birds.

As they are able to recognize with accuracy all species of Illinois birds at sight, and most of them by song, their movement is like that of a gigantic sweep-net 150 feet wide and 300 feet deep, so drawn across the country day by day as to capture every bird which comes in its way—with this difference, that the birds are not actually caught

*See Bull. Ill. State Lab. Nat. Hist., Nos. 3 and 6, Vol. I.

or even inconvenienced, and that nothing can escape the meshes of their well-trained observation.

One of these observers, Mr. H. A. Ray, also a University student, is primarily responsible for the record of distances and kinds of surface over which they travel, carrying for this purpose a pedometer whose action has been carefully tested and repeatedly checked, and a mechanical tally or "lumber-counter"—both used to make a record of the number of paces traveled over each crop or other kind of surface vegetation.

The reports of their travel made to me by Mr. Gross contain every needful detail as to date and time of day; to precise location of their line of march; to temperature, wind, and other features of the weather; to distances traveled in succession over each field or other distinguishable area; to vegetation, wild or cultivated, on each tract; and to the species and numbers of birds identified on each area and in each kind of crop.

General Results of Observations.

The present paper is a discussion of the product of one of their earlier trips, made from August 28 to October 17, 1906, across the state from east to west, from the Indiana line beyond Danville, Ill., to Quincy, on the Mississippi River. It has to do with autumnal conditions in the central part of the state, and is merely preliminary to a comprehensive report on the whole investigation.

The entire distance covered by these observations is 191.86 miles, and the strip from which all birds were accurately determined and numbered was 150 feet in width for this whole distance. The area thus covered was 3519 acres, or 5½ square miles. It included every kind of surface, soil, and vegetation traversed by the observers, with the exception of forests of too lofty or too dense a growth for a complete and certain recognition of their bird population.

The whole number of birds identified was 4804, of which 1620 were English sparrows and 3184 were of native species. The average number of birds seen was 25 for each mile of the trip, which is 1.36 for each acre covered, or 874 for each square mile. The English sparrows averaged .46, and the native species .9, per acre, or 295 per square mile for the sparrows and 579 per square mile for the native birds. The total number of species recognized was 93; but 90 per cent. of the individual birds seen, belonged to 20 of these species, leaving but 10 per cent. for the other 73 species. Indeed, 15 species included 85 per cent. of the individual birds observed, leaving for the other 81 species but 728 birds—an average of 130 birds per square mile, or one bird to each five acres.

It is evident, consequently, that the real dynamic significance of the birds of this district at this time was to be found wholly in the fifteen most abundant species, the remainder being virtually negligible as a general ecological factor.* These fifteen species are arranged in the order of their frequency in the following table, which shows for each the number of individuals seen, the ratio of its numbers to the number of all the birds observed, and the average number of the species per square mile of the area under observation.

TABLE I. THE FIFTEEN MOST IMPORTANT BIRDS, INDIANA LINE TO QUINCY, AUGUST 28 TO OCTOBER 17, 1906

Species	Number	Per cent.	Per sq. mi.
English sparrow	1620	34.	295
Crow-blackbird	517	11.	94
Meadow-lark	312	6.5	57
Crow	226	4.7	41
Cowbird	221	4.6	40
Horned lark	220	4.6	40
Mourning-dove	180	3.7	33
Swamp-sparrow	155	3.2	28
Goldfinch	134	2.7	24
Myrtle warbler	112	2.3	20
White-throated sparrow	93	1.9	17
Field-sparrow	83	1.7	15
Vesper-sparrow	72	1.5	13
Quail	69	1.4	13
Flicker	62	1.3	11
Totals	4076	85.1	741

If we exclude the English sparrow from consideration, as an obnoxious alien whose habits should not be permitted to influence opinion concerning the ninety-two species of our native birds, we must compute the ratios of abundance for the native species with reference to the 3184 such birds identified on this trip. This is an average of 579 per square mile, instead of 874, the former number. To obtain 85 per cent. of all the native birds seen we must add to the above list the next most abundant species, which are the robin, the bluebird, the killdeer, and the blue jay. The following table shows

*A species represented by a relatively small number of birds may have a special ecological significance if it is concentrated in a special class of situations; and may, indeed, be especially important ecologically if the class of situations in which it is concentrated is especially important. This aspect of the general problem must be reserved for discussion when a larger mass and a more comprehensive variety of data are available.

the ratios of abundance and the birds per square mile of the eighteen species of this amended list. The seventy-four native species remaining are now represented by 499 birds—an average of 1 to about seven acres; a proportion far too small to have any general significance.

TABLE II. THE EIGHTEEN MOST IMPORTANT NATIVE BIRDS, INDIANA LINE TO QUINCY.

Species	Number	Per cent.	Per sq. mi.
Crow-blackbird	517	16.	94
Meadow-lark	312	9.8	57
Crow	226	7.1	41
Cowbird	221	7.	40
Horned Lark	220	7.	40
Mourning-dove	180	5.7	33
Swamp-sparrow	155	4.9	28
Goldfinch	134	4.2	24
Myrtle warbler	112	3.5	20
White-throated sparrow	93	3.	17
Field-sparrow	83	2.6	15
Vesper-sparrow	72	2.2	13
Quail	69	2.2	13
Flicker	62	2.	11
Robin	61	2.	11
Bluebird	61	2.	11
Killdeer	60	1.9	11
Blue jay	57	1.8	10

THE VEGETABLE COVERING OF THE SOIL.

As the area traversed on this trip was almost wholly under cultivation, the relation of these birds to the vegetable covering of the soil was virtually their relation to the agricultural and horticultural crops of central Illinois in autumn—almost entirely to the former, since the horticultural area is comparatively insignificant in this part of the state. Nearly all this surface was in fields of ripe corn, the stalks standing in some fields and in others cut and shocked; in blue-grass pastures; in meadows of timothy, clover, and millet, or timothy and clover mixed; in fields of stubble, mostly after a crop of oats; in fields of young wheat; in ground freshly plowed, mainly as a preparation for wheat; and in orchards, almost all of apple. Plowing for wheat was in progress when the trip began, and fields of young wheat were reported in increasing numbers after October 1. Some of the later plowing was doubtless done for corn.

The track of my observers led them also through barnyards, and gardens of vegetables and shrubs, and occasionally across a shrubby ravine or a neglected field which had grown up to weeds. With the exception of a large marshy tract in the bottoms of the Illinois River near Meredosia, there was very little waste land worth mentioning on this line.

For an analysis of the preferences of the principal species of birds with respect to the various classes of situation and kinds of food available to them at the time, it is necessary to take into account the areas in each of the crops along the line of travel. For this purpose the following table has been prepared, showing the total distance traveled through each kind of crop, and the acreage in each from which a complete count and analysis of the bird life was obtained.

TABLE III. CROP AREAS, INDIANA LINE TO QUINCY.

Crop	Miles traveled in crop	Per cent. in each crop	Acres in 50-yard strip	Number of fields	Acres in average field*
Corn	71.87	38.	1306.64	362	32.
Stubble	37.4	19.5	680.56	205	18.2
Wheat	8.48	4.4	155.36	59	17.
Plowed ground	5.76	3.	105.66	34	18.4
Pasture	50.97	26.6	926.65	345	14.
Meadow	8.4	4.5	153.18	51	21.7
Orchard	2.5	1.3	46.7	23	9.5
Miscellaneous	6.48	2.7	134.25	36	....
Totals	191.86		3509.00	1115	

Corn, it will be seen, was the principal crop. A distance of nearly seventy-two miles was traveled through 362 corn fields of an average size of 32 acres per field, and all the birds were determined for 1306.64 acres of this crop. That is, 38 per cent. of the entire journey was in fields of corn. The next largest area was in blue-grass pastures, over which my observers traveled 51 miles, determining the birds of 926.65 acres, which was 26.6 per cent. of the whole area of their observations. Thirty-seven and four tenths miles in fields of stubble, mainly oats, averaging 18.2 acres each, gave a total of 680.56 acres for the 50-yard strip, or 19.5 per cent. of its entire length. Thus

*Virtually all central Illinois farm-fields are rectangular, and the average form of a sufficient number is consequently that of a square. The length of one side of such an average field was found by dividing the entire distance traveled in any crop by the number of fields of that crop crossed. The square of this side is, of course, the area of this average field.

the oats fields were more than one half, and the pastures more than two thirds, the area in corn, and these three crops together covered 83 per cent. of the surface. If to this we add the 4.5 per cent. of meadow-lands, we have nearly 88 per cent. of the total area in corn, oats, and grass (including in the last a small amount of clover, usually growing with timothy).

The surface in wheat is not accurately obtainable from these data, since wheat sowing had not begun and plowing for wheat was not finished when the start was made, but both were finished before the trip was ended. If virtually all the fall plowing was being done for wheat, the area in that crop was about 7 per cent., or 260 acres for the 14 miles traveled through 93 fields. About 2½ miles were traveled through 23 orchards, aggregating 1.3 per cent. of the strip, or 46.7 acres in all. The marshes, waste lands, forests, gardens, farm-yards, brushy hollows, and other miscellaneous tracts examined, amount to 2.7 per cent. of the whole. An immense plain of corn, oats, and grass, the first greatly predominating, with a little wheat, less clover, and an occasional farm orchard—this is the region, quite typical for nearly all the central two thirds of Illinois, from which these data were drawn.

General Distribution according to Crops.

We have next to see how our 4800 birds, belonging to 93 species, —and especially how our 15 most abundant species, represented by 4076 birds,—had distributed themselves over the 3500 acres in these crops actually scrutinized by these observers.

This latter query admits of various answers: (1) we may simply give the number of individuals of each species observed in each kind of crop; (2) we may give the number of species on equal areas of each crop—an acre or a square mile; (3) we may give the percentage of each of the species found in each of the crops; (4) we may compare the actual numbers of each species in each crop with the number which would occur there if the species were uniformly distributed over its area, thus showing where and in what degree the species is densely or sparsely distributed above or below the average; or (5) we may compare several species one with another, and each with all the rest, in a way to show just how and how far they differ in their numerical relations to the various crop areas they inhabit. All these several forms of answer are contained in full in the following tables for our most abundant birds, and from these I will extract

here and there only such data for discussion as seem adapted to a general treatment of the subject.

From Table IV., showing the distribution of all birds without distinction of species for the principal areas actually covered by this inspection, we see that 2249 of these birds were found in pastures, 955 of them in corn fields, 454 in stubble ground, 199 in orchards, 115

Table IV. General Distribution of all Birds, by Crops, Indiana Line to Quincy

Crop	Acres	Acreage per cent.	Birds	Birds per cent.	Birds per acre	Birds per sq. mile
Corn	1306.64	38.	955	20.	.73	468
Stubble	680.56	19.5	454	9.	.67	429
Wheat	155.36	4.4	46	1.	.30	192
Plowed ground	105.66	3.	71	1.5	.67	430
Pasture	926.65	26.6	2249	47.	2.43	1551
Clover	79.08	2.3	51	1.	.65	416
Timothy	57.10	1.7	47	1.	.83	531
Millet	17.	.5	17	....	1.	640
Orchard	46.70	1.3	199	4.	4.23	2726
Yards	11.77	.003	121	2.5	10.28	6580
Swamp	47.16	.013	98	2.	2.08	1331
Timber*	7.34	....	9	....	1.23	785
Miscellaneous	78.	1.1	487	....	....	....

*All forests "skipped" if high or dense.

in meadows, 71 on recently plowed ground, and 46 of them on young wheat. Taking into account the different acreages of these areas and computing the number of birds per square mile in each, we have 2726 per square mile in orchards, 1551 in pastures, 481 in meadows, 468 in corn fields, 430 on plowed ground, 429 on stubble, and 192 on young wheat. A square mile of swamp land, if we may judge by the forty-seven acres examined, would have contained a population of 1331 birds; and a square mile of farmyards, 6580. Compared by percentages of all the birds in each crop, 47 per cent. were in pastures, 20 per cent. in corn, and 9 per cent. in stubble, the ratios in other crops and situations ranging from 4 per cent. down.

The above crops may be divided, from this point of view, into four classes: young wheat, with less than 200 birds to the square mile; corn, stubble, meadows, and plowed ground, with about 450 each; pastures, with over 1500; and orchards, with 2700 birds to the like area. The fact that birds are nearly as common in old stubble

fields as in corn, suggests that it is not the grain in either case which attracts them there, but rather the seeds of the weeds by which both kinds of fields are generally covered in fall. Their preference for pasture-lands is probably due to the amount of food found by them in the droppings of stock, and to the greater abundance of insect life in such a situation. Other comparative conclusions may best be postponed until the special assemblages of birds characterizing each of these principal classes of situations are more fully discussed.

The Principal Birds in each Crop.

The next four tables give us the data of the distribution and abundance of the principal species of birds as related to the principal crops. In Table V. we have the numbers identified of the twelve most abundant birds in each kind of crop, without reference to differences in acreage. In Tables VI.-VIII. the list of species is reduced to nine by dropping the three passing migrants. In Table VI. the number of birds per section, or square mile, of each crop is given for each of the species; in Table VII. are the percentages of each species found in the various crops; and in Table VIII. we have in each crop column, percentages showing for each species the ratio of the number of birds

Table V. Number of Principal Birds in Principal Crops, Indiana Line to Quincy

	Corn	Stubble	Wheat	Pasture	Meadow	Plowed ground	Orchard	Yards	Weeds	Shrubbery	Fallow and waste
English sparrow	562	38	....	530	10	9	101	119	251	....	....
Crow-blackbird	21	22	....	445	....	....	....	9	....	....	....
Meadow-lark	49	97	21	122	20	3	....	....		....	...
Crow	12	7	1	190	3	13	....	...	....	....	..
Cowbird	2	2	1	133	20	1	...	....	(62*)	....	....
Horned lark	6	26	7	141	1	38	....	1	....	....	...
Mourning-dove	53	41	1	73	8	1	3	....	..	....	
Swamp-sparrow	14	7	....	20	15	...	7	....	....	5	87
Goldfinch	20	7	4	56	....	....	16	....	28	3	....
Myrtle warbler	30	3	...	47	1	2	13	....	...	5	11
White-throated sparrow	19	8	1	15	....	...	16	....	21	13	....
Field-sparrow	11	2	1	33	1	....	8	....	11	16	....

*Sorghum.

TABLE VI. NUMBER OF BIRDS PER SQUARE MILE IN EACH CROP

	Corn	Stubble	Wheat	Pasture	Meadow	Plowed ground	Orchard
English sparrow	275	36	.....	366	48	55	1383
Crow-blackbird	10	21	.....	307	.....	......	......
Meadow-lark	24	92	86	84	98	18	......
Crow	6	7	4	131	15	79	......
Cowbird	1	2	4	89	98	6	......
Horned lark	3	25	29	97	5	230	.....
Mourning-dove	26	39	4	50	39	6	42
Goldfinch	10	7	17	39	......	...	220
Field-sparrow	5	2	4	23	5		110
All birds	468	429	192	1551	481	430	2726

TABLE VII. PERCENTAGE OF EACH SPECIES IN EACH OF THE PRINCIPAL CROPS*

	Corn	Stubble	Wheat	Pasture	Meadow	Plowed ground	Orchard	Yards	Shrubbery	Sorghum	Waste
English sparrow	35	2	...	33	.6	.5	6	7	...	..	15
Crow-blackbird	4	4	....	90	...	....	....	2	....	..	....
Meadow-lark	16	31	7	38	7.	1.	....	...	..	....	....
Crow	5	3	....	84	1.	6.	....	....	..	....	...
Cowbird	1	1	....	60	9.	...	...	....	...	28	....
Horned lark	3	12	3	64	..	17.	...	...	....	....	....
Mourning-dove	29	23	1	40	4.	1.	2	....	....	....	....
Goldfinch	15	5	3	42	....	..	12	....	2	..	21
Field-sparrow	13	2	1	40	1.		10	....	19	....	14
All birds	20	9	1	47	2.	1.	4	3	1	1	11

*Read from left to right.

TABLE VIII. RATIO OF EACH SPECIES IN EACH CROP TO ALL BIRDS IN THAT CROP*

	Corn	Stubble	Wheat	Pasture	Meadow	Plowed ground	Orchard
English sparrow	.59	.08	....	.24	.09	.13	.51
Crow-blackbird	.02	.05	......	.20	......	.....	......
Meadow-lark	.05	.21	.45	.05	.18	.04	......
Crow	.01	.02	.02	.09	.03	.18	......
Cowbird	....	.....	.02	.06	.18	.01	......
Horned lark	....	.06	.15	.06	.01	.53	......
Mourning-dove	.06	.09	.02	.03	.07	.01	.01
Goldfinch	.02	.02	.09	.03	.....	.....	.08
Field-sparrow	.01	.....	.02	.02	.01	.....	.04

*Read from above downwards.

of that species found in that crop to the total number of all birds found in the same crop.

From Table VIII. it will be seen that the principal *corn-field* species at the times and places of this trip was the English sparrow, to which more than half the birds seen in corn fields belong, and that the mourning-dove and the meadow-lark were the species next in abundance there—6 per cent. and 5 per cent. respectively. In *stubble fields* the meadow-lark was the most abundant species, making about a fifth of all the birds seen in such fields. The next in order of abundance were the mourning-dove, the English sparrow, the horned lark, and the crow-blackbird, present in ratios ranging from 9 per cent. to 5 per cent. The meadow-lark was also much the most abundant bird on fields of *young wheat,* where it made 45 per cent. of all the birds seen; and the horned lark and the goldfinch were next to this in number, one third and one fifth as great respectively. The principal *pasture* species were the English sparrow (24 per cent.) and the crow-blackbird (20 per cent.), with the crow, the cowbird, the horned lark, and the meadow-lark following in numbers ranging from a third to about a fifth the number of the sparrows. In *meadows,* on the other hand, the meadow-lark and the cowbird were in the lead, each 18 per cent. of all the meadow birds identified, and the English sparrow and the mourning-dove were about half as numerous. On *fall plowing* more than half the birds were horned larks, and the only other abundant species were the crow (18 per cent.) and the English

sparrow (13 per cent.). In the small number of *orchards* traversed the English sparrow was at this time much the most abundant bird (51 per cent.). The other common species were the goldfinch (8 per cent.), the field-sparrow (4 per cent.), and a few passing migrants—the myrtle warbler and the white-throated sparrow, for example. (See Table V.)

The Principal Species Separately.

English Sparrows.—From these tables we learn that about two thirds of the English sparrows were in corn fields and pastures, and in about equal numbers in each; that approximately half as many were found in waste weedy fields as in pastures; and that the remainder were about equally divided between barn-yards and orchards. Some 52 per cent. of this species—those in corn fields, stubble, and waste lands—were among weeds, and 40 per cent. of them were following farm stock in pastures and yards. Those in orchards (6 per cent.) were doubtless there mainly for shelter and rest. The table of numbers per square mile (Table VI.) shows that orchards were the favorite resort of the sparrows. Barn-yards, pastures, and corn fields were their principal feeding grounds, and only scattering numbers occurred in stubble, meadows, and plowed fields. Not a single one of the 1620 sparrows noted on this trip was seen in the 59 fields of young wheat. These sparrows were, in a word, barn-yard, corn-field, and pasture birds, and were doubtless feeding mainly on weed seeds and undigested fragments of grain.

Crow-blackbirds and Crows.—Blackbirds, on the other hand, were seen to be at this time essentially birds of the pasture, 90 per cent. of them occurring there, and only 4 per cent. in corn fields, 4 per cent. in stubble, and 2 per cent. in farmyards. Practically the same may be said of the crows, whose ratios of abundance are close copies of the preceding excepting for the 6 per cent. on plowed ground, the 1 per cent. in meadows, and the absence of crows from barn-yards. During this whole trip of 192 miles, only 12 crows and 21 blackbirds were seen in the 1300 acres of corn covered by these observations—an average of 6 crows and 10 blackbirds per square mile of corn. It was suggestive of a useful feature of the habits of crows that an average of 79 of these birds per square mile were seen on plowed ground, where they could have found little if any food except insect larvæ—mainly white-grubs. The record for blackbirds is disturbed by the fact that they were moving southward when the trip began, as is shown by their occurrence at the rate of 7.2 per mile of travel during the first half of the period of this trip and at only 1.1 per mile during the last half.

Meadow-larks.—That good genius of the farm, the meadow-lark, was evidently at home almost everywhere on the farm premises, as is shown especially by the numbers per square mile, which are approximately equal for stubble fields, meadows, pastures, and fields of young wheat (Table VI.). These birds were about a fourth as numerous in corn fields, and a fifth as numerous on plowed ground, as in meadows and fields of stubble, and somewhat more numerous in these latter situations than in pastures and young wheat; but taking into account the actual crop areas in the country covered (Table VII.) we find meadow-larks so distributed through these crops as to be about equally common in pastures and stubble fields, and about half as common in corn, with only 7 per cent. of their number in wheat and meadow-lands respectively. Their recorded numbers on plowed ground amounted to only 1 per cent. of the whole number seen. The occurrence of 86 of these birds per square mile in fields of young wheat suggests a possible economic depredation, of which, in fact, they have been sometimes accused.

Cowbirds.—The cowbird's record of occurrence for this trip would be almost exclusively that of a pasture and meadow species if it had not been for a flock of 62 seen in a field of sorghum, feeding on the seeds. Even including these in the ratios, 60 per cent. were in pastures and 9 per cent. in meadows, the remaining distribution being merely a scattering one. Tested by the number of species per square mile in each crop, as shown by Table VI., the cowbird shows no very decided choice between pastures and meadow-lands, averaging 89 per square mile for the former and 98 for the latter. The species was evidently migrating at the time, as only one example was seen during the last seventy miles of the trip.

It should be noted at this point that these generalizations concerning gregarious birds, which roost in company or feed in flocks, require a much larger body of data than those for birds of solitary habit. The averages of this paper are hence more likely to require amendment for blackbirds, cowbirds, and crows, as information accumulates, than for the other species of our list.

Horned Larks.—The birds of this species found in central Illinois were all of the prairie variety, *praticola*. With habits much like those of the meadow-lark, they differed from that species widely in their local distribution, especially in their preference for plowed ground, on which they occurred at the rate of 230 per square mile as against 18 meadow-larks for the same area. Their next preference was for pastures, where 97 per square mile were found, the remainder occurring mostly on stubble and young wheat, 25 and 29 per square mile respectively. Nearly two thirds of their actual numbers were

found in pasture-lands, 17 per cent. were on plowed ground, and 12 per cent. on stubble. The remainder were in fields of wheat and corn, 3 per cent. in each.

Mourning-doves.—Mourning-doves were mainly in pastures (40 per cent.), corn fields (29 per cent.), and stubble lands (23 per cent.), these three situations thus containing 92 per cent. of all these birds recorded. As tested by the average numbers per square mile, their preferences seem much less definite. While commonest on pasture-lands (50 to the square mile), they were almost as abundant in stubble, meadows, and orchards,—about 40 per mile in each situation,—and more than half as common in corn fields (26 to the mile). Their occurrence on plowed ground and wheat was only occasional, and their numbers there were trivial.

Goldfinches and Field-sparrows.—These little birds were at this time similarly distributed, occurring in the same situations and in nearly equal ratios in each. Both were most numerous in pastures, 42 per cent. for the goldfinches and 40 per cent. for the field-sparrows, and were otherwise rather equally scattered through corn fields and orchards and on waste patches of weeds. In birds per square mile they were about three times as common in orchards as in all the other places taken together, their next apparent preference being for pasture-lands, where, however, the sparrows averaged only 23 to the square mile and the goldfinches 39.

Summary for Principal Species.

Summarizing now the data for all these nine species taken together as one group, we find an average of 1755 birds to the square mile of orchard, more than three fourths of this number English sparrows; 1186 per square mile in pasture, nearly one third of them English sparrows; 394 to the square mile of plowed ground, 230 of these being horned larks; 373 to the square mile of corn, three fourths of these English sparrows; 308 to the square mile of meadow-lands, where meadow-larks and cowbirds made each about a third of the number; 231 to the square mile of stubble, about two fifths of them meadow-larks; and 148 to the square mile of young wheat, of which meadow-larks made nearly three fifths. This statement may be still further generalized and simplified by saying that the number of these birds per square mile varies in round numbers from 150 in young wheat to eight times that number in pastures, and to nearly 12 times the same number in orchards; and that the intervening ratios were 230 per square mile in stubble, 300 in meadows, 375 in corn, and 400 on plowed ground.

The wide differences of their numbers in these several situations can not be taken to demonstrate corresponding differences in the local or ecological preferences of these birds, although they do indicate something of the effects which birds may be producing on equal areas in these crops. If sparrows resort to orchards largely for resting places and for protection against the wind, they would tend to accumulate there in much greater numbers to the unit of area in a country containing only scattering small orchards than in one where many large orchards were within their reach; and if horned larks decidedly prefer bare ground to a grassy turf, there will be a larger number of them in plowed fields to the square mile when but few fields have been lately plowed than when the larger part of the agricultural area has just been broken up.

Ratios of Frequency and Preference.

Bearing in mind the necessity thus shown for an intelligent analysis and interpretation of certain of the facts, the following tables of *frequency ratios,* and *coefficients of preference* may be found convenient as a compact systematic summary of my data. The frequency ratios express the comparative densities of population on each kind of surface, for each species tabulated and for all the birds of our list. Taking the ratio of the number of birds found in a crop to the whole number of birds as a dividend, and the ratio of the area in that crop to the entire area as a divisor, the quotient is the frequency ratio for those birds and that crop. If a species were equally distributed over the entire area studied, this ratio would be 1 for all situations and all crops. If 40 per cent. of the area were in corn, then 40 per cent. of the birds of that species would be in corn fields. If, on the other hand, only 20 per cent. of the birds were in corn, the density of population in corn fields would be expressed by the frequency ratio of 50 per cent. All ratios below 1 indicate a density of population less than that resulting from a uniform distribution; and all greater than 1, a density above that limit.

The coefficients of preference are found by dividing in succession the frequency ratios of a species for each crop by its frequency ratios for each of the other crops. They are thus a measure of the degree of preference of the species for one crop or situation over another; and as arranged in my tables of coefficients following, they enable us to see just where the preferences lie, and how they compare one with another. Turning, for example, to the coefficient table for the mourning-dove (Table XI., p. 324), we find at the left of the table a list of the crops in which this bird is found, and a like list,

in the same order, at the top. At the place of intersection of the line of figures for one crop with the column of figures for another, will be found the coefficient of the preference of the mourning-dove for one of these crops as compared with the other,—the standard crop being the one whose name is at the head of the column. Selecting, as an illustration, the column headed "corn," and following it to its intersection with the line for "meadows," we find there the coefficient 1.16,—the meaning of which is that for every hundred mourning-doves found in a given area of corn fields, 116 would be found, according to our data, in a like extent of meadows. If any number of these birds found in corn fields is multiplied by the coefficient 1.16, the product is the number which we may expect to find in meadows of the same aggregate area.

Reading upward from 1 in any column, one gets a descending series of expressions for the densities of the dove population in crops less attractive than the one named at the head of the column; and reading downward from the same point, a reverse series for crops more attractive to doves than this standard crop. The figures on one side of the diagonal line of 1's are the reciprocals of those on the other side.

Tables of this description will be useful for a comparison of the distribution and ecology of the several species at different seasons and in different situations, and for a comparative study of the statistics of bird distribution in different parts of the state and in different states.

Table IX. Ratios of Frequency, Most Abundant Birds, Indiana Line to Quincy.

	Corn	Stubble	Wheat	Plowed ground	Pastures	Meadows	Orchards	Yards	Shrubs	Swamps	Weeds
English sparrow	.92	.1	......	.17	1.24	.13	4.61	2333.	.....	......	60
Crow-blackbird	.11	.21	.....	....	3.42	......	......	6.66	.....	......	......
Meadow-lark	.42	1.59	1.59	.33	1.43	1.56	......	....	.....	.....	......
Crow	.13	.15	.....	2.	3.16	.22	......	....	.....	....	......
Cowbird	.026	.05	......	....	2 26	2.	......	....	.....	......	......
Horned lark	.079	.61	.68	5.66	2.41	......	......	....	......	......	......
Mourning-dove	.76	1.18	.23	.33	1.50	.88	1.54	....	....	.....	.....
Goldfinch	.39	.26	.69	....	1.58	.....	9 23	....	750	......	14000
Field-sparrow	.34	.10	.23	......	1.50	.22	7.69	....	3500	....	5500
All birds	.53	.47	.23	.33	1.76	.44	3.08	8.33	.....	1.54	......

TABLE X. COEFFICIENTS OF PREFERENCE, ALL BIRDS, INDIANA LINE TO QUINCY.

	Wheat	Plowed ground	Meadows	Stubble	Corn	Swamp	Pastures	Orchards	Yards
Wheat	1.	.70	.52	.49	.43	.14	.13	.075	.028
Plowed ground	1.43	1	.75	.70	.62	.21	.19	.11	.04
Meadows	1.91	1.33	1.	.94	.83	.29	.25	.14	.053
Stubble	2.05	1.42	1.1	1.	.89	.31	.27	.15	.057
Corn	2.30	1.61	1.2	1.1	1.	.34	.30	.17	.064
Swamp	6.70	4.67	3.5	3.3	2.9	1.	.88	.5	.185
Pastures	7.65	5.33	4.	3.7	3.3	1.1	1.	.57	.21
Orchards	13.39	9.33	7.	6.6	5.8	2.	1.75	1.	.37
Yards	36.22	25.24	18.8	18.	16.	5.4	4.7	3.	1.

TABLE XI. COEFFICIENTS OF PREFERENCE, NINE MOST ABUNDANT BIRDS, INDIANA LINE TO QUINCY.

English sparrow	Stubble	Meadows	Plowed ground	Corn	Pastures	Orchards	Weeds	Yards
Stubble	1.	.77	.6	.11	.08	.022	.002	.00004
Meadows	1.3	1.	.76	.14	.10	.03	.002	.00006
Plowed ground	1.7	1.31	1.	.19	.14	.04	.003	.00007
Corn	9.2	7.08	5.41	1.	.74	.2	.015	.0004
Pastures	12.4	9.54	7.29	1.35	1.	.27	.02	.0005
Orchards	46.1	35.5	27.	5.01	3.72	1.	.08	.002
Weeds	600.	462.	353.	65.	48.4	13.	1.	.03
Yards	23330.	17946.	13724.	2536.	1881.	506.	38.9	1.

TABLE XI.—*Continued.*

Crow-blackbird	Corn	Stubble	Pastures	Farmyards
Corn	1.	.52	.03	.02
Stubble	1.91	1.	.07	.03
Pastures	31.1	16.28	1.	.48
Farmyards	60.55	31.71	2.06	1.

Meadow-lark	Plowed ground	Corn	Pastures	Meadows	Stubble	Wheat
Plowed ground	1.	.79	.23	.21	.21	.21
Corn	1.27	1.	.29	.27	.26	.26
Pastures	4.33	3.40	1.	.92	.90	.90
Meadows	4.73	3.71	1.09	1.	.98	.98
Stubble	4.82	3.78	1.11	1.02	1.	1.
Wheat	4.82	3.78	1.11	1.02	1.	1.

Crow	Corn	Stubble	Meadows	Plowed ground	Pastures
Corn	1.	.87	.55	.065	.04
Stubble	1.15	1.	.68	.075	.05
Meadows	1.69	1.47	1.	.11	.07
Plowed ground	15.4	13.3	9.09	1.	.63
Pastures	24.3	21.	14.4	1.58	1.

TABLE XI.—*Continued.*

Cowbird	Corn	Stubble	Meadows	Pastures
Corn	1.	.52	.013	.01
Stubble	1.92	1.	.025	.02
Meadows	76.9	40.	1.	.88
Pastures	80.	45.2	1.13	1.

Horned lark	Corn	Stubble	Wheat	Pastures	Plowed ground
Corn	1.	.13	.12	.03	.01
Stubble	7.72	1.	.90	.25	.11
Wheat	8.61	1.11	1.	.28	.12
Pastures	30.51	3.95	3.54	1.	.43
Plowed ground	71.65	9.28	8.32	2.35	1.

Mourning-dove	Wheat	Plowed ground	Corn	Meadows	Stubble	Pastures	Orchards
Wheat	1.	.70	.30	.26	.19	.15	.15
Plowed ground	1.43	1.	.43	.38	.28	.22	.21
Corn	3.30	2.33	1.	.86	.64	.51	.49
Meadows	3.96	2.67	1.16	1.	.75	.59	.57
Stubble	5.13	3.58	1.55	1.34	1.	.79	.77
Pastures	6.52	4.55	1.97	1.70	1.27	1.	.97
Orchards	6.70	4.67	2.03	1.74	1.31	1.03	1.

TABLE XI—*Concluded.*

Field-sparrow	Stubble	Meadows	Wheat	Corn	Pastures	Orchards	Shrubs	Weeds
Stubble.	1.	.45	.43	.29	.07	.013	.00003	.00002
Meadows	2.2	1.	.95	.65	.15	.028	.00006	.00004
Wheat.	2.3	1.05	1.	.68	.15	.03	.00007	.00004
Corn	3.4	1.55	1.48	1.	.23	.04	.0001	.00006
Pastures	15.	6.82	6.52	4.41	1.	.19	.0004	.0003
Orchards	76.9	35.	33.4	22.6	5.13	1.	.002	.001
Shrubs	35000.	15909.	15217.	10294.	2333.	455.	1.	.64
Weeds	55000.	25000.	23913.	16177.	3666.	715.	1.57	1.

Goldfinch	Stubble	Corn	Wheat	Pastures	Orchards	Shrubs	Weeds
Stubble	1.	.66	.38	.17	.028	.00035	.00002
Corn	1.50	1.	.56	.25	.042	.00052	.00003
Wheat	2.65	1.77	1.	.44	.075	.00092	.00005
Pastures	6.04	4.05	2.29	1.	.171	.0021	.0001
Orchards	35.5	23.7	13.4	5.84	1.	.0123	.0006
Shrubs	2885.	1923.	1087.	475.	81.3	1.	.0534
Weeds	53846.	35897.	20290.	8861.	1517.	18.7	1.

The data of Table XI., arranged under the different species of birds, may also be classified, as in Table XII., according to the different situations, or the different kinds of crops, frequented by the birds. The one table shows us how each kind of bird is related to the various crops; and the other, how each crop is related to the various kinds of birds. Table XI. is thus essentially ornithological, showing the preferences of each kind of bird with respect to the food resources and places of resort offered it by each kind of crop or other situation. Table XII. is essentially agricultural, and shows the principal bird visitants of each kind of crop, brought into comparison with respect to their preferences for that crop alone. Referring, for example, to the section for corn, we see at the left the names of the principal birds of the corn field, arranged from above downwards in the order of their frequency in corn, the least frequent visitants uppermost. We may use this table to compare any species with another as a corn-field bird—the horned lark with the meadow-lark, for instance—by finding the place of the one species in the diagonal series of 1's and going up or down the column until the line for the other species is reached. The coefficient at the intersection of the column with the line shows the frequency relation of the one bird to the other. In this way we learn that for every hundred horned larks, 532 meadow-larks were found in corn, or, what is virtually the same thing, that for every hundred meadow-larks there were 19 horned larks on an average in corn.

It is also easy to ascertain from these tables whether there is any group of species which seem especially and strongly attracted to any special situation. We notice such a group in the horned larks, mourning-doves, and meadow-larks, considered as visitants of fields of stubble, and found there respectively about 3 times, 5 times, and 7½ times as frequently as are blackbirds; in the crows and the horned larks, considered as visitants of plowed fields, found there approximately 6 times and 17 times as frequently as are meadow-larks; and in the field-sparrows, goldfinches, meadow-larks, mourning-doves, and English sparrows in the corn fields, in which they occur from 3 to 8 times as frequently as blackbirds. The principal meadow birds, by these tables, are mourning-doves, meadow-larks, and cowbirds, since they occur in meadows 7 times, 12 times, and 15 times as commonly as English sparrows; while pastures apparently afford a common meeting ground for all the birds of this list of most important species, the coefficient of the blackbird—the most frequent pasture bird—being less than three times that of the English sparrow, the least frequent of these birds in pastures.

Numerous questions of cause, effect, and controlling condition are suggested by these data, some of them readily answerable and others doubtfully so, but the discussion of ecological problems may best be postponed until the data here presented may be brought into comparison with those obtained from other trips, made at other seasons and in other parts of the state.

TABLE XII. COEFFICIENTS OF PREFERENCE, TABULATED BY CROPS

Corn	Cowbird	Horned lark	Crow-blackbird	Crow	Field-sparrow	Goldfinch	Meadow-lark	Mourning-dove	English sparrow
Cowbird	1.	.33	.24	.20	.08	.07	.06	.03	.03
Horned lark	3.04	1.	.72	.61	.23	.20	.19	.10	.09
Crow-blackbird	4.23	1.39	1.	.85	.32	.28	.26	.14	.12
Crow	5.	1.65	1.18	1.	.38	.33	.31	.17	.14
Field-sparrow	13.08	4.30	3.09	2.61	1.	.87	.81	.45	.37
Goldfinch	15.	4.94	3.55	3.	1.15	1.	.92	.51	.42
Meadow-lark	16.15	5.32	3.82	3.23	1.24	1.08	1.	.55	.46
Mourning-dove	29.23	9.62	6.91	5.85	2.24	1.95	1.81	1.	.83
English sparrow	35.38	11.64	8.36	7.08	2.71	2.36	2.19	1.21	1.

TABLE XII.—*Continued.*

Stubble	Cowbird	Field-sparrow	English sparrow	Crow	Crow-blackbird	Goldfinch	Horned lark	Mourning-dove	Meadow-lark
Cowbird	1.	.5	.5	.33	.24	.19	.08	.04	.03
Field-sparrow	2.	1.	1.	.66	.48	.38	.16	.08	.06
English sparrow	2.	1.	1.	.66	.48	.38	.16	.08	.06
Crow	3.	1.5	1.5	1.	.71	.58	.24	.13	.09
Crow-blackbird	4.2	2.1	2.1	1.40	1.	.81	.34	.18	.13
Goldfinch	5.2	2.6	2.6	1.73	1.24	1.	.43	.22	.16
Horned lark	12.2	6.1	6.1	4.07	2.90	2.35	1.	.51	.38
Mourning-dove	23.6	11.8	11.8	7.87	5.62	4.54	1.93	1.	.74
Meadow-lark	31.8	15.9	15.9	10.6	7.57	6.11	2.61	1.35	1.

Wheat	Mourning-dove	Field-sparrow	Horned lark	Goldfinch	Meadow-lark
Mourning-dove	1.	1.	.34	.33	.14
Field-sparrow	1.	1.	.34	.33	.14
Horned lark	2.96	2.96	1.	.99	.43
Goldfinch	3.	3.	1.01	1.	.43
Meadow-lark	6.91	6.91	2.34	2.30	1.

Plowed ground	English sparrow	Meadow-lark	Mourning-dove	Crow	Horned lark
English sparrow	1.	.52	.52	.08	.03
Meadow-lark	1.94	1.	1.	.16	.06
Mourning-dove	1.94	1.	1.	.16	.06
Crow	11.76	6.06	6.06	1.	.35
Horned lark	33.29	17.15	17.15	2.83	1.

TABLE XII.—*Concluded.*

Pastures	English sparrow	Meadow-lark	Mourning-dove	Field-sparrow	Goldfinch	Cowbird	Horned lark	Crow	Crow-blackbird
English sparrow....	1.	.87	.83	.83	.78	.55	.51	.39	.36
Meadow-lark..	1.15	1.	.95	.95	.90	.63	.59	.45	.42
Mourning-dove	1.21	1.05	1.	1.	.95	.66	.62	.47	.44
Field-sparrow	1.21	1.05	1.	1.	.95	.66	.62	.47	.44
Goldfinch...........	1.27	1.10	1.05	1.05	1.	.70	.66	.50	.46
Cowbird............	1.82	1.58	1.51	1.51	1.43	1.	.93	.71	.66
Horned lark	1.94	1.69	1.61	1.61	1.52	1.07	1.	.76	.70
Crow	2.55	2.21	2.11	2.11	2.	1.40	1.31	1.	.92
Crow-blackbird.....	2.76	2.39	2.28	2.28	2.16	2.51	1.42	1.08	1.

Meadows	English sparrow	Crow	Field-sparrow	Mourning-dove	Meadow lark	Cowbird
English sparrow......................	1.	.59	.59	.15	.08	.07
Crow................................	1.69	1.	.1	.25	.14	.11
Field-sparrow	1.69	1.	1.	.25	.14	.11
Mourning-dove	6.77	4.	4.	1.	.57	.44
Meadow-lark..........................	12.	7.09	7.09	1.77	1.	.78
Cowbird	15.80	9.09	9.09	2.27	1.28	1.

CONCLUSION.

The circumstance that the data of this paper are summarized in numerical tables must not be permitted to obscure the fact that they merely present a fixed picture of a fleeting condition; that they are to be taken only as numerical generalizations of the observations here recorded, and do not, in themselves, warrant much by way of inference beyond their immediate contents. The view of the autumnal bird life of central Illinois which we get by their means is like a short-time photograph of a changing scene—changing so rapidly, indeed, that the effects of its transformations are noticeable even in the picture itself; for it is evident, especially from the list of species

at the end of this paper, that there was some bird migration southward during the fifty days of this trip. Summer residents of central Illinois diminish in numbers, or even wholly disappear, during its course, winter residents come in, and migrants to the south, not seen in the earlier days of the journey, become abundant as they move across the line of march in the western part of the state.

Some of the effects of this migration were seen a fortnight later in the very different picture of bird life presented on a trip made by these same observers, October 31 and November 1, from Cairo, the southernmost point in Illinois, to Ullin, some twelve and a half miles north. Here, instead of the scanty average of 874 birds per square mile, as found in central Illinois, there were over 9 to the acre, or 5882 to the square mile. Two thirds of these were crow-blackbirds and robins—45 per cent. of the first and 23 per cent. of the second—and the next most abundant species was the white-throated sparrow (7 per cent.), and next to that, the quail (4 per cent.). The meadowlark was reduced to 2 per cent. of the birds observed; and, more remarkable still, the English sparrow, to a little more than 1 per cent. Into the angle formed by the meeting of the Ohio River with the Mississippi, birds from the north were dropping down by thousands as into a huge pocket, to be held there, no doubt, until cold weather or a diminution of their food supply should drive them farther south.

Definite conclusions of permanent value concerning the numbers and significance of the bird life of the state evidently can not be drawn until many such pictures as these have been assembled, compared, and adjusted in their right relations; and it has been the principal object of this paper to describe and illustrate one process, at least, by which the materials necessary to a correct general view of the ornithological ecology of the state may be brought together and made available.

LIST OF BIRDS IDENTIFIED, INDIANA LINE TO QUINCY, ILL.

Check-list No.	Species	I*	II	III	IV	V	VI
190	Botaurus lentiginosus	....	....	....	....	....	1
194	Ardea herodias	1	...	....	....	..	....
201	Butorides virescens	1	....	...	....	....	....
214	Porzana carolina	1	1		....	....	....
261	Bartramia longicauda	1	1	1	....	...	....
273	Oxyechus vociferus	55	....	2	3		....
289	Colinus virginianus	....	...	..	.	14	55
305	Tympanuchus americanus	2	7	....	..	...	....
316	Zenaidura macroura	56	22	14	42	32	14
325	Cathartes aura	4	....	2	...	...	....
331	Circus hudsonius	....	1	1	....	....	1
337	Buteo borealis	2	....	....	....	1	1
347a	Archibuteo lagopus sancti-johannis	1	....	..	1	....	....
357	Falco columbarius	....	....	..	....	....	1
360	Falco sparverius	3	1	...	....	...	....
387	Coccyzus americanus	2	1	....	....	....	....
390	Ceryle alcyon	1	....	....	....	...	...
393	Dryobates villosus	....	....	....	....	....	1
394c	Dryobates pubescens medianus	....	....	1	1	...	8
402	Sphyrapicus varius	....	....	2	...	....	....
406	Melanerpes erythrocephalus	21	....	1	...	....	....
409	Centurus carolinus	.	....		1	...	2
412	Colaptes auratus	23	8	14	14	2	1
420	Chordeiles virginianus	21	....	...	...	.	....
423	Chætura pelagica	2	1	...	5	1	8
444	Tyrannus tyrannus	2	...	...	..	....	1
456	Sayornis phœbe	....	....	2	....	1	3
461	Contopus virens	1	...	1	...	...	....
466	Empidonax traillii	2	....	..	....	....	....
474b	Otocoris alpestris praticola	41	61	49	17	2	50
477	Cyanocitta cristata	11	3	15	12	2	14
488	Corvus brachyrhynchos	14	5	19	20	158	10
494	Dolichonyx oryzivorus	...	..	1		....	....
495	Molothrus ater	60	24	63	73	....	1
498	Agelaius phœniceus	3	....	.	....	...	5
501	Sturnella magna	82	19	50	31	20	110
511b	Quiscalus quiscula æneus	309	65	11	95	.	37
517	Carpodacus purpureus	..	..	..	....	..	4
——	Passer domesticus	188	447	112	683	5	185
529	Astragalinus tristis	12	1	10	12	....	99
540	Poocætes gramineus	....	8	11	...		52
542a	Passerculus sandwichensis savanna		....	...	1	...	6
546	Coturniculus savannarum passerinus	16	11	4	1	5	7
548	Ammodramus leconteii	....	..	....	...	12	11
554	Zonotrichia leucophrys	....	....	....	2	....	6
558	Zonotrichia albicollis	....	...	....	2	....	91

*I=Indiana line to Champaign, Aug. 28–Sept. 1. II=Urbana to Decatur, Sept. 17–21. III=Decatur to Springfield, Sept. 24–29. IV=Springfield to Jacksonville, Oct. 1–4. V=Jacksonville to Meredosia, Oct. 5–8. VI=Meredosia to Quincy, Oct. 12–17.

LIST OF BIRDS IDENTIFIED—*Continued.*

Check-list No.	Species	I	II	III	IV	V	VI
560	Spizella socialis		1		....	....	....
563	Spizella pusilla	2	1	1	1	1	77
567	Junco hyemalis	....	....	....	3	1	32
581	Melospiza cinerea melodia	....	..	....	4	1	19
583	Melospiza lincolni	...	..	...	3	....	3
584	Melospiza georgiana	....	....	1	12	32	110
585	Passerella iliaca	....	..	....	...	....	2
587	Pipilo erythrophthalmus	..	....	...	....	....	14
593	Cardinalis cardinalis	....	....	1	....	1	1
598	Cyanospiza cyanea	1	....	....	..	....	
604	Spiza americana	2	....	....	....	....	....
611	Progne subis	4	....	....	...	...	....
612	Petrochelidon lunifrons	6	....	...	....	....	....
613	Hirundo erythrogaster	3	....	...	...	..	....
614	Iridoprocne bicolor	...	....	...	....	9	2
619	Ampelis cedrorum	....	..	....	....	....	1
622	Lanius ludovicianus	3	1	....	...	....	1
624	Vireo olivaceus	....	.	1	....	....	...
626	Vireo philadelphicus	....	..	1	...	....	....
629	Vireo solitarius	....	1	....	....	....	....
645	Helminthophila rubricapilla	1	..	....	....	....	....
646	Helminthophila celata	....	....	...	..	....	1
647	Helminthophila peregrina	....	1	.	....	....	....
655	Dendroica coronata	....	2	34	33	7	36
657	Dendroica maculosa	....	1	....	...	....	....
667	Dendroica virens	..	2	....	1	....	....
672	Dendroica palmarum	2	...	..	1	....	....
681d	Geothlypis trichas brachidactyla	...	.	1	....	..	....
687	Setophaga ruticilla	....	2	...	...	...	...
697	Anthus pensilvanicus	...	....	...	....	....	25
703	Mimus polyglottos		...	....	1	..	....
704	Galeoscoptes carolinensis	2	1	.	....	...	...
705	Toxostoma rufum	....	2	2	1	....	....
719	Thryomanes bewickii	..	...	1	....	....	....
721	Troglodytes aëdon	3	..	....	1	..	2
724	Cistothorus stellaris	...	...	2	2	....	3
726	Certhia familiaris americana	....	....	..	2	..	1
727	Sitta carolinensis	....	....	....	....	....	2
728	Sitta canadensis	....	....	3	....	....	1
731	Bæolophus bicolor	...	....	....	....	....	10
735	Parus atricapillus	....	....	....	..	....	22
736	Parus carolinensis	....	....	3	4	....	....
748	Regulus satrapa	....	....	....	2	....	2
749	Regulus calendula	....	....	....	..	....	6
758a	Hylocichla ustulata swainsoni	....	1	....	...	...	....
761	Merula migratoria	4	15	18	5	....	19
766	Sialia sialis	..	...	10	11	....	40
?*	....	3	1	1	2	6	10

*Identification uncertain.

BULLETIN

OF THE

ILLINOIS STATE LABORATORY

OF

NATURAL HISTORY

Vol. VII.	SEPTEMBER, 1909	Article X.

THE ORIBATOIDEA OF ILLINOIS.

BY

HENRY E. EWING, A.M.

LIST OF BIRDS IDENTIFIED—*Continued.*

Check-list No.	Species	I	II	III	IV	V	VI
560	Spizella socialis		1		....	....	....
563	Spizella pusilla	2	1	1	1	1	77
567	Junco hyemalis	....	....	....	3	1	32
581	Melospiza cinerea melodia	....	..	....	4	1	19
583	Melospiza lincolni	...	..	...	3	....	3
584	Melospiza georgiana	....	....	1	12	32	110
585	Passerella iliaca	....	..	....	...	....	2
587	Pipilo erythrophthalmus	..	....	...	....	....	14
593	Cardinalis cardinalis	....	....	1	....	1	1
598	Cyanospiza cyanea	1	....	....	..	....	
604	Spiza americana	2	....	....	....	....	....
611	Progne subis	4	....	....	...	...	....
612	Petrochelidon lunifrons	6	....	...	....	....	....
6[illegible]	Hirundo erythrogaster	3	....	....	...	..	....
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
624	Vireo olivaceus	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
626	Vireo philadelphicus	...	..	1	...	....	....
629	Vireo solitarius	....	1	...	....	....	....
645	Helminthophila rubricapilla	1	..	....	....	....	....
646	Helminthophila celata	....	....	...	..	....	1
647	Helminthophila peregrina	....	1	.	....	....	....
655	Dendroica coronata	....	2	34	33	7	36
657	Dendroica maculosa	....	1	....	...	....	....
667	Dendroica virens	...	2	....	1	....	....
672	Dendroica palmarum	2	...	..	1	....	....
681d	Geothlypis trichas brachidactyla	...		1	....	..	....
687	Setophaga ruticilla	....	2	...	...	...	...
697	Anthus pensilvanicus	...	....	...	....	....	25
703	Mimus polyglottos		...	....	1	..	....
704	Galeoscoptes carolinensis	2	1	.	....	...	...
705	Toxostoma rufum	....	2	2	1	....	....
719	Thryomanes bewickii	..	...	1	....	....	....
721	Troglodytes aëdon	3	..	....	1	..	2
724	Cistothorus stellaris	...	...	2	2	....	3
726	Certhia familiaris americana	....	....	.	2	..	1
727	Sitta carolinensis	....	....	....	....	....	2
728	Sitta canadensis	....	....	3	....	....	1
731	Bæolophus bicolor	..	....	....	....	....	10
735	Parus atricapillus	....	....	....	...	....	22
736	Parus carolinensis	....	....	3	4	....	....
748	Regulus satrapa	....	....	....	2	....	2
749	Regulus calendula	....	....	....	..	....	6
758a	Hylocichla ustulata swainsoni	....	1	...	...	...	....
761	Merula migratoria	4	15	18	5	....	19
766	Sialia sialis	.. .	...	10	11	....	40
?*	.....	3	1	1	2	6	10

*Identification uncertain.

BULLETIN

OF THE

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URBANA, ILLINOIS, U. S. A.

VOL. VII. SEPTEMBER, 1909 ARTICLE X.

THE ORIBATOIDEA OF ILLINOIS.

BY

HENRY E. EWING, A.M.

Article X.—*The Oribatoidea of Illinois.* By Henry E. Ewing.

Introduction.

The mites of the group *Oribatoidea*, though abundant in this country, have received but little study. About a hundred species have been recorded from America. Out of this number over 90 per cent. are new species, yet with this very large per cent. of new species only two new genera (*Gymnobates* Banks and *Tumidalvus* Ewing) are peculiar to our country. Our fauna is especially rich in the abdominal-winged forms (*Pterogasterea*). The number of the *Pterogasterea* described from this country, up to the present, is over 40. Nearly all of these winged forms have a shiny integument, which fact may have caused their more ready discovery and the apparently much greater percentage of winged forms here than in Europe.

The *Oribatoidea* are appropriately called beetle-mites because of their hard, chitinized integument. They are quite distinct however from the mites of those groups which are parasites or pseudoparasites of beetles, and which for this reason have been called beetle-mites by some persons. The internal anatomy and life history of this group have been studied very carefully by A. D. Michael, of England, to whom the writer is indebted for a large collection of named European species. The physiology and embryology of the group are almost entirely unknown. Economically the beetle-mites have no great importance.

The writer is very much indebted to Dr. J. W. Folsom, of the department of zoology of the University of Illinois, for assistance in many ways. Mr. J. D. Hood, a specialist in the study of the *Thysanoptera*, has not only collected material for the author from many parts of the state, but has in most cases furnished mounted specimens and also added notes upon their

habits, etc. The following persons have aided very materially in collecting specimens: Mr. C. A. Hart, systematic entomologist of the State Laboratory of Natural History; Mr. J. J. Davis, assistant to the State Entomologist; Mr. J. L. Pricer, A. M., graduate student in entomology; and Messrs. J. Zetek, R. D. Glasgow, and H. Glasgow, all students of the University of Illinois.

Dr. S. A. Forbes has kindly permitted the author to work up the oribatid collections of the State Laboratory of Natural History, in which type specimens of the species described in this paper have been deposited.

Methods.

In making collections of oribatids several methods may be employed. It is very desirable that these mites be collected alive, in order that they may be studied before being placed in a preserving fluid. All notes on color and the position of the bristles and pseudostigmatic organs should be made from living specimens. Individual mites can be very readily transferred on a camel's hair brush to a collecting vial, to be taken to the laboratory and killed.

Specimens are best killed in hot water or hot alcohol, when they die in an extended position, most favorable for study. While the specimens are still in the alcohol, notes should be made on the shape of the pteromorphæ, the pseudostigmata, and the pseudostigmatic organs, since it is hard to study the form of these parts in the dorsal or ventral view of permanently mounted specimens. Mr. Michael suggests the use of dilute acetic acid instead of alcohol as a preservative.

In order to collect oribatids in large numbers, I use with great success a modification of the Berlese method described by Howard in "Entomological News", Vol. XVII., 1906, pages 49-54. If vegetable debris is passed through a sieve before being treated by the Berlese method, the number and variety of small arthropods that may thus be obtained is surprisingly large. A simple but satisfactory method consists in placing

the siftings on a flat dish suspended over a large funnel, and placing the funnel and all in the sunlight. The sunlight drives the mites out of the siftings, and they fall through the funnel into a vial below.

The most convenient and satisfactory mounting media for oribatids are Canada balsam and dammar balsam. Dissections of the mouth-parts are frequently necessary. Material must often be rendered partially transparent by means of potassic hydrate or eau de Labrraque.

In making the drawings I used an Abbé camera lucida. The measurements were made with an ocular micrometer.

External Anatomy.

The body in the *Oribatoidea* (Fig. 1) consists of an anterior narrower region termed the cephalothorax, and a posterior, much larger, portion termed the abdomen. The union of these two regions is more intimate in some genera than in others. There is usually an evident division between the cephalothorax and the abdomen except in the genera *Scutovertex* and *Amerus*. In two genera, *Hoploderma* and *Phthiracarus*, the cephalothorax is hinged to the abdomen in such a way that the former can be folded down against the ventral surface of the latter.

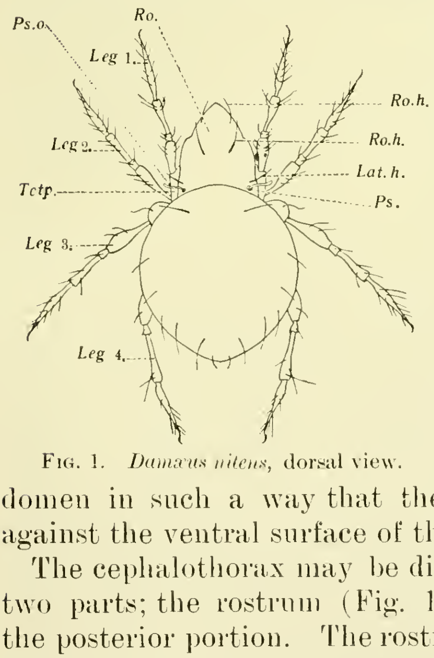

Fig. 1. *Damaeus nitens*, dorsal view.

The cephalothorax may be divided into two parts; the rostrum (Fig. 1, *Ro.*) and the posterior portion. The rostrum is the anterior hood-like portion which protects the mouth-parts. Upon the rostrum is found a pair of stout hairs termed rostral hairs (Fig. 1, *Ro. h.*); sometimes the

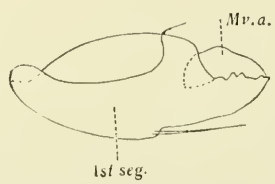

Fig. 2. *Oribata banksi*, mandible.

rostrum bears an additional pair of hairs. Underneath the rostrum may be seen the mouth-parts, which consist of mandibles (Fig. 2), palpi (Fig. 3, *Pa.*), maxillæ (Fig. 3, *Max.*), and the maxillary lip (Fig. 3, *Max. l.*). From the maxillary lip project the maxillæ and the palpi. The maxillæ are curved and blade-like, and are large and highly developed in the genus *Hoploderma*. The palpi consist usually of five segments, and as a rule are very small; in the genera *Phthiracarus* and *Hoploderma*, however, they are large. On the posterior part of the cephalothorax are found the following organs: pseudostigmata, pseudostigmatic organs, lamellæ, lamellar hairs, interlamellar hairs and sometimes a translamella, and often one or more pairs of tectopedia. The pseudostigmata (Fig. 4, *Ps.*), formerly supposed to be the true stigmata, are situated near the abdominal margin and usually close to the lateral margin of the cephalothorax. They are of various forms, though usually cylindrical or funnel shaped. From each pseudostigma projects the pseudostigmatic organ (Fig. 4, *Ps. org.*). This may be filiform, fungiform, setiform, clavate, or subglobose, and is often pectinate or dentate. The lamellæ consist of either blade-like chitinous projections, or of mere ridges. They vary greatly in size and shape, and are situated on the dorso-lateral part of the cephalothorax. Sometimes the lamellæ project in a free end which may extend to the apex of the rostrum or even beyond it. From the tip of the lamellæ project a pair of prominent bristles, termed the lamellar hairs. The tectopedia, of which there may be as many as three pairs, are generally blade-like, are situated on the sides of the cephalothorax, and have either a tactile function or serve to protect the coxæ.

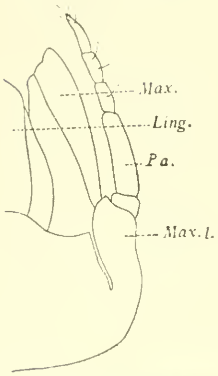

FIG. 3. *Oribata banksi*, mouth-parts.

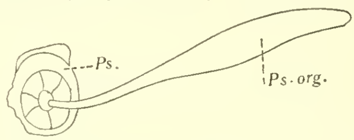

FIG. 4. *Oribata setosa*, pseudostigma and pseudostigmatic organ.

The abdomen has the following structures: dorsum, ventral plate, anal covers, genital covers, often pteromorphæ, and sometimes large bristles. The dorsum of the abdomen consists of a single large chitinous plate. The ventral plate varies much in size; is sometimes confluent with the dorsum, and contains the genital and anal apertures. The genital aperture is anterior to the anal aperture, and is closed by two chitinous "folding doors", known as the genital covers. The anal aperture is similarly closed, its "folding doors" being termed the anal covers. Sometimes on the dorsum, rarely on the ventral plate, long bristles may be found, though frequently the abdomen is hairless. In some genera, as *Pelops* and *Oribata*, there are chitinous wing-like expansions of the abdomen termed pteromorphæ (Pl. XXXIII., Fig. 4, *pter.*).

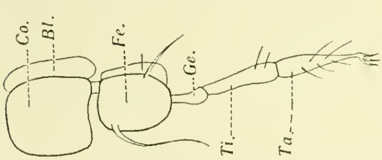

Fig. 5. *Oribata mollicoma*, leg 4.

The legs (Fig. 5) consist of five segments, namely, coxa, femur, genual, tibia, and tarsus. The coxa (*Co.*), or basal segment, is usually the shortest and stoutest of the segments, and sometimes has a blade-like expansion (*Bl.*) on one side. The femur (*Fe.*) is usually the largest and sometimes the longest segment. The genual (*Ge.*) is very small and inconspicuous. The tibia (*Ti.*) is usually subequal to the tarsus (*Ta.*), and often bears, especially on the front pair of legs, a long tactile hair at its distal end. The tarsus ends in either one (monodactyle) claw or three (tridactyle) claws, and never in two except in the species *Nothrus anauniensis*.

The parts most used for systematic purposes are the pseudostigmatic organs, lamellæ, translamella, pteromorphæ, and ungues.

Internal Anatomy.

Most of the internal organs of the oribatids may be divided into three systems: the digestive, tracheal, and reproductive systems. The digestive and reproductive organs occupy most of the body cavity.

The digestive system includes the mouth, pharynx, œsophagus, ventriculus or stomach, intestine, and rectum. The mouth leads into a not well marked off region, called the pharynx, which is sometimes broader than the œsophagus. The posterior end of the œsophagus is generally enlarged, forming the ingluves just in front of the stomach. The ventriculus, or stomach, is very large, and its outline can often be seen through the integument of light-colored species or in specimens which have recently emerged from the nymphal skin. I have found that treatment with acetic acid and mounting in glycerine will frequently show the internal organs very plainly. The stomach is almost like a spherical bag in most cases, with its anterior wall lying at the division between the cephalothorax and abdomen, while its posterior wall extends to a point almost above the anal opening. Extending out from the stomach on each side at the posterior part is a blind pouch or cœcum. The cœca vary somewhat in size, shape, and situation with the species. The intestine and rectum are very short and often resemble a C-shaped tube, leading from the posterior wall of the stomach to the anus. In connection with the digestive process is a small pair of glands situated on the front wall of the ventriculus or stomach.

The tracheal system exists only in the adult forms and is absent in the *Hoplodermidæ*. The tracheæ usually consist of from eight to twelve main trunks, which start from the acetabula of the legs, most of them extending backwards in a wavy course to the posterior end of the abdomen, where they become slightly enlarged at their termination to form air-sacs. The tracheæ are always unbranched.

The nervous system has not been well worked out in the case of the *Oribatoidea* but consists of a sub- and a supra-œsophageal ganglion, which have nerves running to the important organs.

Situated on the sides of the abdominal cavity in the case of some species, is a small sac which opens to the exterior through the integument. This apparatus is supposed to have an excretory function. The region of the cephalothorax is largely occupied by muscles controlling the legs and the mouth-

parts. No circulatory system has been demonstrated in the beetle-mites although some *Acarina* have a pulsating organ called the heart.

The reproductive system occupies a large part of the lateral and posterior portions of the abdomen. In the case of the male, the organs consist of a large central gland, the testis, which has two ducts, the vasa deferentia, leading from it. These unite to form the ejaculatory duct, which opens through a small penis. The reproductive organs of the female consist of a paired or unpaired ovary, and of two large oviducts which pass backwards along the sides of the abdomen to its posterior end, to form there the vagina, which opens to the exterior through a large protrusible ovipositor. The ovipositor is usually trifid, and may possess a few small hairs on its distal end. In specimens treated with glycerine and acetic acid, the large ovipositor may often be seen in repose with its proximal end against the posterior wall of the abdomen and its distal end at the entrance of the genital opening.

Life History.

Most *Oribatoidea* are oviparous; some species, however, according to Michael, are ovoviviparous, and a few viviparous. It is believed by some that many if not all the *Oribatoidea* are parthenogenetic. Up to the present time they have never been found in copulation.

The larvæ, as in the case of most of the *Acarina*, have only three pairs of legs, which always have tarsi with monodactyle claws.

When the larvæ transform into the nymphs they have the full number of legs of the adult, but in other respects are very different from the mature forms. Instead of being a dull brown or black color, they frequently are tinted with red, yellow, or pink, and, more marked yet, their external form may be very different from that of the adult. Instead of having a body almost or quite free from any integumentary projections, as is generally the case in the adult, they may have large, leaf-like, or sword-shaped integumentary processes. These integu-

mentary processes are sometimes so large that they almost completely conceal the rest of the body. In the case of the nymphs of some of the species of *Liacarus*, the leaf-like appendages are radially arranged around the central part of the body, giving the whole creature a beautiful stellate appearance. In the nymphal state the integument is usually poorly chitinized. As would be expected, the sexual organs are not developed in the case of the nymphs.

About ten days are passed by the inert nymph preliminary to the appearance of the adult. Upon the splitting of the old nymphal skin the adult usually emerges, leaving its "old clothes" behind; but this is not always the case, as is shown by the genus *Neoliodes*, the members of which carry throughout life the cast nymphal skin—which can readily be removed by treatment with potassium hydroxide. The members of the genus *Damaeus* almost always bear a part of the old nymphal skin supported by means of the bristles on the dorsum of the abdomen, but not adhering firmly to the newly formed integument as in the case of the species of *Neoliodes*. The adults immediately after emerging from the nymphal skin are usually lighter in color than the older forms; in other respects they are the same.

Habits.

The *Oribatoidea* are very small creatures of about the size of a pin-head, or even smaller. They may be easily found under logs (slightly decayed), under bark, in rubbish, under stones, in moss, or may be shaken from the branches of trees or collected in grass sweepings. They live very largely upon fungi, or, to some extent, upon plant juices, and apparently are never predaceous although the *Hoplodermidae* have large and powerful mandibles. Most of the beetle-mites, though blind, are very sensitive to light, and avoid it when possible. I have found that they have a very sensitive touch and also have the power of smell, which sense may be situated in the so-called pseudostigmatic organs.

Not being well armed for aggressive warfare, this group is very remarkable in its adaptation for defense. The thick chitinous integument of the group when taken into consideration with the special structures of the *Oribatidæ*, the pteromorphæ or abdominal wings, affords an excellent protection against some of their smallest, though most troublesome, enemies. When the least disturbed, most of the species with these chitinous abdominal wings will fold the legs up underneath the body and close down the abdominal wings over them, so that they are almost or quite completely concealed and protected. In case of the *Hoplodermidæ*, which have the cephalothorax hinged to the abdomen, they at once feign death upon being disturbed, fold themselves into a small ball by bending the cephalothorax down over the ventral surface of the abdomen, at the same time drawing up the legs, and are thus completely covered by the cephalothorax.

In their movements the *Oribatoidea* are sluggish as compared with the other *Acarina*. As a rule the smooth, shiny species are more active than the larger, rough species. The species of the genera *Neoliodes* and *Nothrus* are especially slow in their movements. One species, *Zetorchestes micronychus*, which though common in Europe has been found in only one place in America, is quite unique in being the only oribatid which is saltatorial.

Many of the *Oribatoidea* pass the winter in moss. Some of the species which live upon the leaves of trees, apparently winter under the bark.

The Taxonomy of the Higher Groups of the Oribatoidea.

Michael, the expert acarologist already mentioned, regards the group of beetle-mites as a family, and in his monograph of them in "Das Tierreich" (Lief. 3, 1898) divided the group into seven subfamilies. I can hardly agree with this author in all respects as to this division, for although the characters which separate some of his subfamilies are fundamental and are correlated with differences in habit as well as structure, others are somewhat variable and hardly of more than generic im-

portance. I refer for example to the separation of his subfamily *Notaspidinæ* from the subfamilies *Damæinæ* and *Nothrinæ*, based upon the absence or presence of the lamellæ. While the lamellæ are sometimes very constant in their shape and size in a single species, yet, taking all the species together, we can get an insensible gradation from forms with enormous shelf-like expansions, which conceal much or most of the cephalothorax from above, to small chitinous ridges or only wrinkles of the integument which may vary in some cases so as to be almost invisible. This fact, taken together with the fact that there are few if any supplementary characters in support of this division, make it rather artificial, if not unwarrantable, to accord it the same rank with his other divisions of the group. On the other hand, his separation of those forms which have the cephalothorax anchylosed to the abdomen from those which have the cephalothorax hinged to the same (his *Phthiracarinæ*) is certainly based on characters of family portance. This is more convincingly evident when we consider the other important points of difference, which are given below.

Forms with Cephalothorax Anchylosed to Abdomen.	*Forms with Cephalothorax Hinged to Abdomen.*
Body frequently depressed.	Body always compresed.
With tracheæ.	Without tracheæ.
Ventral plate anchylosed to dorsal plate	Ventral plate not anchylosed to dorsal plate.
Genital and anal openings situated apart.	Genital and anal openings usually together
Legs frequently long or slender or moniliform.	Legs always stout.
Mouth-parts very small, or rudimentary.	Mouth-parts large, mandibles enormous.
Palpi with five segments.	Palpi with only four segments.
Femora generally stouter than the other segments of the legs.	Femora subequal in width to the other segments of the legs.
Cephalothorax never with a median carina.	Cephalothorax often with a median carina.

Abdomen never with a chitinous hood-like projection from its anterior margin.	Abdomen sometimes with a chitinous hood-like projection from its anterior margin.
Claws of legs usually small and monodactyle; if tridactyle the dactyles are usually unequal.	Claws of legs always stout; if tridactyle the dactyles are subequal.

When we consider all these points of difference, it appears to us that they are not only of sufficient importance for the separation of the two forms into different families, but that they might even justify a wider separation and a higher rank. About the only important characters the two have in common are the chitinous integument and the presence of the pseudostigmata and the pseudostigmatic organs. Mr. Banks, in his treatise on "The Acarina, or Mites" (Proc. U. S. Nat. Mus., Vol. XXVIII., p. 1–114), separates those forms which have the cephalothorax hinged to the abdomen from the other oribatids, under the family name of *Hoplodermidæ.* This separation and name the author of this paper has adopted.

Mr. Michael's separation of those forms which possess abdominal wings from those which do not ("*Apterogasterea*") we accept, raising both forms, however, to family rank, and giving the first-mentioned the old name *Oribatidæ,* since it contains the old genus *Oribata.* This division is not altogether happy for two reasons: first, many authors may consider the small, shelf-like chitinous expansions from the shoulders of the abdomen in the case of some genera (as *Notaspis* and *Tegeocranus*) as homologous with the true abdominal wings, or pteromorphæ; second, there are not many other fundamental characters in support of the division. Notwithstanding these facts, we consider the development of abdominal wings—especially when taking into account their defensive value and the habits of mites possessing them, and some other points of difference as well—as of sufficient importance to entitle such forms to family rank.

Since we have applied the family name *Oribatidæ* to those forms having abdominal wings, the remaining forms, the "*Apterogasterea*", we naturally consider as constituting a family, us-

ing for it the name *Nothridæ*, derived from the genus *Nothrus*, which name has been previously so applied by G. Canestrini and made a subfamily name by Mr. Michael.

Having thus created three families out of the group to which the old family name *Oribatidæ* was given, we regard the group as a superfamily, as suggested by Mr. Banks, including in it, however, as already stated, three families for the two (*Oribatidæ* and *Hoplodermidæ*) recognized by that author. The following is a summary of the characters of the superfamily *Oribatoidea*:

Integument generally well chitinized, which gives the individuals a beetle-like appearance. Cephalothorax with a pair of funnel-shaped or cylindrical structures on the dorsum which are called pseudostigmata, from each of which projects an elongate specialized organ, or seta, the pseudostigmatic organ; chitinous blade-like expansions termed lamellæ often present. Palpi small, with five segments, generally hidden by the rostrum; mandibles chelate. Abdomen usually oval; ventral surface covered by a large chitinous plate termed the ventral plate; dorsal surface often with a large chitinous wing-like expansion on each side, known as the pteromorpha. Legs composed of five segments, the distal segment bearing a claw (unguis) which is either monodactyle or tridactyle.

KEY TO THE FAMILIES OF ORIBATOIDEA.

1. Cephalothorax and abdomen immovably fused together; body never compressed; mouth-parts small; with tracheæ opening at the acetabula of the legs; legs often long or slender .... 2.

   Cephalothorax hinged to the abdomen and capable of being folded down over the ventral surface of the same; body compressed; mouth-parts large; without tracheæ; legs stout .... HOPLODERMIDÆ.

2. Abdomen possessing chitinous wings, or pteromorphæ; integument usually smooth and shiny and always well chitinized; legs never stout or with swollen segments .... ORIBATIDÆ.

Abdomen without wings; integument often rough or sculptured and sometimes very little chitinized; legs frequently stout or moniliform.......................NOTHRIDÆ.

The three families of the superfamily *Oribatoidea* we divide into 29 genera, which are distributed as follows: *Oribatidæ*, 5 genera; *Nothridæ*, 21 genera; and *Hoplodermidæ*, 3 genera.

KEY TO THE GENERA OF ORIBATIDÆ.

1. Superior bristles of body spatulate; mandibles long and slender; integument sometimes rough or pitted.. PELOPS.
   Superior bristles never spatulate; integument smooth... 2.
2. Tarsi of first pair of legs broad at the tip; pteromorphæ attached to the sides of the cephalothorax as well as to the abdomen.................................GYMNOBATES.
   Tarsi of first pair of legs tapering at the tip; pteromorphæ attached to the abdomen only......................... 3.
3. Claws of the tarsi tridactyle............................ 4.
   Claws of tarsi monodactyle..................... ORIBATODES.
4. Lamellæ large, attached to the cephalothorax by their posterior margins only..................... ORIBATELLA.
   Lamellæ moderate, attached to the cephalothorax by their inner margins............................. ORIBATA.

KEY TO THE GENERA OF NOTHRIDÆ.

1. Mandibles rod-like, serrate...................... SERRARIUS.
   Mandibles chelate.. 2.
2. Last pair of legs distant from the others and saltatorial...... .... ZETORCHESTES.
   Last pair not distant from the others, nor saltatorial, being used for crawling........................ .... 3.
3. Abdomen apparently divided into three parts by a pair of oblique sutures passing backward from the posterior edge of the cephalothorax to the middle of the lateral margins of the abdomen..................... TRIZETES.
   Abdomen without such oblique sutures .... 4.
4. Integument thin and little chitinized; variously colored.. 19.

Integument well chitinized; color brown.................. 5.
5. Cephalothorax with lamellæ .... 6.
Cephalothorax without lamellæ .... 12.
6. Body smooth.. 7.
Body rough.. 8.
7. Last three pairs of legs situated under the body.. LIACARUS.
Last three pairs of legs situated at the sides of the body .... NOTASPIS.
8. No demarcation between the cephalothorax and abdomen .... SCUTOVERTEX.
Cephalothorax and abdomen plainly divided............. 9.
9. Ungues monodactyle; femora I and II pedunculate...... 10.
Ungues tridactyle........................ .... 11.
10. Lamellæ large, blade-like.................. TEGEOCRANUS.
Lamellæ merely low chitinous ridges......... CARABODES.
11. Femur I pedunculate.................... CHAUNOPROCTUS.
Femur I not pedunculate...... .... CEPHEUS.
12. Legs slender, longer than body, segments pedunculate.. 13.
Legs short and stout.................................. 14.
13. Cephalothorax and abdomen coalescing at the median plane.................................. AMERUS.
Cephalothorax and abdomen plainly divided...... DAMÆUS.
14. Ungues monodactyle: dorsum of abdomen convex...... 15.
Ungues tridactyle .... 16.
15. Genital and anal covers separate; situated in the ventral plate.................................. HERMANNIA.
Genital and anal covers contiguous; no ventral plate present...... .... LOHMANNIA.
16. Dorsum of abdomen convex......................... 17.
Dorsum of abdomen flat or concave................... 18.
17. Abdomen with concentric rings on the dorsum; ventral plate present........................... NEOLIODES.
Abdomen without concentric rings on the dorsum; ventral plate absent.......................... TUMIDALVUS.
18. Body elliptical; leg II with tectopedia..... CYMBÆREMÆUS.
Body rectangular; leg II without tectopedia.... NOTHRUS.

19. Abdomen without transverse suture.... TRHYPOCHTHONIUS.
Abdomen with transverse suture..................... 20.
20. Ungues tridactyle, with inner dactyle less than half as long as the others; cephalothorax truncate in front............................ PARHYPOCHTHONIUS.
Ungues either monodactyle or tridactyle, if tridactyle, dactyles of equal length; cephalothorax not truncate in front............................ HYPOCHTHONIUS.

KEY TO THE GENERA OF HOPLODERMIDÆ.

1. Genital and anal openings situated apart; ventral plate large............................ MESOPLOPHORA.
Genital and anal openings situated together; ventral plate small or rudimentary............................ 2.
2. Ungues monodactyle; genital and anal covers separate............................ HOPLODERMA.
Ungues tridactyle; genital and anal covers coalescing. .... PHTHIRACARUS.

DESCRIPTIONS OF SPECIES.

Thirty-three species from Illinois are described in the following pages, and of this number twelve are new. In every case the author has made figures illustrating the new species, and a few figures have been made of some of our most common American species. The species are arranged in the natural order under each genus, a key being given to aid in their identification. The genera and families are similarly arranged, the leading characters being given for each group.

FAMILY ORIBATIDÆ.

Forms with the cephalothorax and abdomen immovably fused together; body not compressed; mouth-parts very small; tracheæ opening at the acetabula of the legs. Abdomen possessing chitinous wing-like expansions called pteromorphæ; integument usually smooth and shiny. Legs never with swollen or moniliform segments.

Genus Oribatella Banks.

Ungues tridactyle; pteromorphæ attached to the abdomen only; lamellæ large, attached to the cephalothorax by their posterior margins.

Two species:

Pteromorphæ truncate. not extending beyond the anterior margin of abdomen .... *quadridentata.*
Pteromorphæ extending almost to the tip of the rostrum. .... *ovalis.*

Oribatella quadridentata Banks.

1895. *Oribatella 4-dentata*, Banks, Trans. Amer. Ent. Soc., Vol. XXII., p. 9.
1898. *Oribata quadridentata*, Michael, Das Tier., Lief. 3, p. 19.

Dark brown; integument brittle; surface slightly rough.

Cephalothorax about as broad as long and almost entirely hidden from above by the lamellæ, which are very large, projecting beyond the rostrum and ending each in two subequal cusps; lamellæ almost touching each other and twice as long as broad. No translamella. Lamellar hairs almost straight, pectinate and directed forward. There are two very much curved. pectinate rostral hairs; also a pair of similar but straight interlamellar hairs; pseudostigmatic organ large, clavate, and pectinate, about two thirds as long as the lamellæ. Just behind each pseudostigma is a short, stout, pectinate bristle.

Abdomen almost as broad as long, pteromorphæ truncate, not extending beyond the anterior margin of the abdomen. their anterior margin slightly concave. There is a whorl of about a dozen stout, curved, pectinate bristles around the margin of the abdomen. Anal covers slightly larger than the genital covers, and situated about their own length from the posterior margin of the abdomen and twice their length from the genital plates. Legs small and short.

Length, 0.56 mm.; breadth, 0.38 mm.

Under logs and boards. Collected by the writer at Urbana, Ill. Many specimens. Mr. Banks has confirmed the determination of this species.

Oribatella ovalis C. L. Koch.

1835. *Oribates ovalis*, C. L. Koch, Crust. Myr. Arach., Heft 3, Tab. 5.
1877. *Oribates ovalis*, Canestrini & Fanzago, Atti Ist. Venet., Ser. 5, Vol. IV., p. 82.
1855. *Oribata nitens*, Nicolet, Arch. Mus. Paris, T. VII., p. 433, Pl. IV., Fig. 6.
1884. *Oribata punctata*, Michael, Brit. Orib., Vol. I., p. 253, Pl. IX., Fig. 1–14.
1883. *Oribates nicoletii*, Berlese, Acari, Myr., Scorp., Fasc. III., Nr. 3.
1895. *Oribatella armata*, Banks, Trans. Amer. Ent. Soc., Vol. XXII., p. 9.
1898. *Oribata ovalis*, Michael, Das Tier., Lief. 3, p. 19.

Dark walnut-brown; integument thick and very resistant; surface pitted.

Cephalothorax short and almost entirely hidden by the large lamellæ. Lamellæ greatly enlarged, as long as the cephalothorax; pseudostigmata pyriform; pseudostigmatic organ large, clavate, and about two thirds as long as the cephalothorax.

Abdomen oblong. Pteromorphæ very large, almost as long as the entire body, and ending anteriorly in a long, sharp-pointed process. Anal covers about half as long again as the genital covers.

Legs rather small and hidden by the large pteromorphæ. The anterior pair project about half their length in front of the apex of the rostrum; the posterior extend slightly beyond the posterior margin of the abdomen. Tibia of the first two pairs rather short.

Length, 0.60 mm.; breadth, 0.42 mm.

In moss. Collected by C. A. Hart, from the pitcher-plant (*Sarracenia purpurea*), in bog, at Cedar Lake, Ill., and by the author at Homer, Ill.

Genus ORIBATA Latreille.

Superior bristles not spatulate; mandibles stout; integument usually smooth; pteromorphæ attached to the abdomen only; ungues tridactyle; lamellæ attached by means of their inner margins to the dorsal surface of the cephalothorax.

KEY TO SPECIES.

1. Pteromorphæ rounded anteriorly and extending almost to the tip of the rostrum.................................. 2.
Pteromorphæ truncate in front and not extending beyond the anterior margin of the abdomen...... .... 4.
2. Pteromorphæ smooth; antero-ventral margin deeply emarginate................................ ....*emarginata*.
Pteromorphæ somewhat wrinkled; antero-ventral margin irregularly rounded....... .... 3.
3. Abdomen unicolor; with four large, subequal bristles situated on the posterior margin...... .... *robusta*.
Abdomen with eight dark spots on the dorsum; no bristles on the posterior margin.................... .. *octopunctata*.

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4. With a translamella...................... .... 5.
Without a translamella.................... .... 10.
5. Pseudostigmatic organ short, subcapitate.................... 6.
Pseudostigmatic organ long, clavate or lanceolate.......... 9.
6. Translamella short, very broad, being as broad as long. .... *spinogenuala*.
Translamella very narrow, almost reduced to chitinous ridges.................. .... 7.
7. Translamella curved gradually backward from the ends to the center................... .. .. *unimaculata*.
Translamella doubly curved, giving rise to a small median cusp .... 8.
8. Lamellar hairs one and a half times as long as the lamellæ..*turgida*.
Lamellar hairs scarcely as long as the lamellæ....... *minuscula*.
9. Femora of legs II with lateral blade-like expansions. *fuscipes*.
Femora of legs II without lateral blade-like expansions............ .... *artilamellata*.

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10. Abdomen oblong, being much longer than broad.......... 11.
Abdomen globose .... 13.
11. Pseudostigmatic organs slender, lanceolate, and clavate. 12.
Pseudostigmatic organs short, subcapitate........... *arborea*.

12. Lamellæ large, broad, three fourths as long as the cephalothorax .... *virginica.*
Lamellæ very small, short, about one fourth as long as the cephalothorax .... *parvilamellata.*
13. Abdomen hairless .... *illinoisensis.*
Abdomen with prominent hairs .... *banksi.*

Oribata emarginata Banks.

1895. *Oribata emarginata*, Banks, Trans. Amer. Ent. Soc., Vol. XXII., p. 7.

Dark brown; integument very hard; surface smooth.

Lamellæ absent. Rostrum stout, with a rounded anterior end; rostral hairs curved and pectinate; tectopedia blade-like and two thirds as long as the rostrum; pseudostigmatic organ clavate and pectinate, about as long as the tarsus of leg I; interlamellar hairs stout and pectinate.

Abdomen slightly pyriform and hairless; pteromorphæ slightly pointed, extending forward almost to the tip of the rostrum; anal and genital openings far apart; genital covers about two thirds as long as the anal covers. Females with a long, segmented ovipositor, which is often extended when the mite is killed in hot water. This ovipositor is trilobed distally, each fork bearing two large bristles.

Legs subequal in length; fourth pair longest; second pair with very stout femora. First pair of legs twice as long as the cephalothorax; tarsus the longest segment, bearing a large plumose hair at a point about one third the distance from the proximal to the distal end of the segment; tibia much shorter than the tarsus and globose distally; genual as long as the tibia, but only about half as broad; femur large; coxa small.

Length, 0.89 mm.; breadth, 0.50 mm.

Under logs and in rubbish. Collected by the writer at Arcola, Urbana, Galesburg, Chicago, and Marshall, Ill. Mr. Banks has confirmed the determination of this species.

Oribata robusta Banks. (Pl. XXXIII., Fig. 4.)

1895. *Oribata robusta*, Banks, Trans. Amer. Ent. Soc., Vol. XXII., p. 7.

Uniform light brown; integument thin and brittle.

Cephalothorax broader than long. The lamellæ and translamella consist each of a narrow blade on edge; translamella slightly narrower than the lamellæ and continuous with them, the whole being sublunate; lamellar hairs as long as the cephalothorax, straight and pectinate; rostral hairs stout, curved, and pectinate, a little longer than the pseudostigmatic organ.

Abdomen broader than long, with a few small hairs; pteromorphæ very long and prominent, projecting beyond the tip of the rostrum, rounded in front and pointed behind. Anal covers three fifths as broad as long, and situated one half their length from the posterior margin of the abdomen; genital covers about two thirds as long as the anal covers, similar to them in form, and situated about twice their length from the same.

Legs subequal in length; hind pair slightly longest; tibia and tarsus of leg I subequal, genual one half as long as the tibia, femur a little longer than the genual. The femur of leg II is very much enlarged, and is half as long again as the femora of the two posterior legs.

Length, 0.88 mm.; breadth, 0.62 mm.

Collected by myself at Urbana, Ill. Three specimens. Mr. Banks has confirmed this determination from specimens sent to him by the author.

Oribata octopunctata, n. sp. (Pl. XXXIV., Fig. 7.)

Light yellowish brown; integument thin.

Cephalothorax broad; pseudostigmatic organ very long, recurved, with a thin peduncle and a much enlarged, pectinate, subcylindrical head; interlamellar hairs straight, pectinate, short, and inclined toward the median plane, but projecting very little forward; rostral hairs similar to the lamellar hairs but curved.

Abdomen broad, hairless, with a longitudinal row of four small, oval dark spots on each side, the anterior spots being much the largest; a few similar but very minute spots on the dorsum also. Pteromorphæ free, projecting almost to the tip of the rostrum; both the anal and genital covers situated about their length anterior to the anal covers.

Length, 0.54 mm.; breadth, 0.40 mm.

In moss. Collected by the writer at Homer, Ill. Several specimens.

Oribata spinogenuala, n. sp. (Pl. XXXIII., Fig. 1.)

Dark reddish brown; integument thick and brittle.

Cephalothorax broad; lamellæ horizontal and broad, being broadest at the tips; lamellæ with cusps; lamellar hairs as long as the lamellæ and pectinate; pseudostigmatic organ short, with small peduncle and large clavate head; interlamellar hairs long, pectinate, and straight; rostral hairs about as long as the lamellar hairs and curved.

Abdomen two thirds as broad as long; pteromorphæ narrow, truncate, and lying close to the sides of the body; genital covers two thirds as long as the anal covers and situated twice their own length in front of the latter. There is a row of short, stout, almost straight hairs around the margin, and about eight hairs on the summit of the dorsum.

Legs short and subequal.

Length, 0.60 mm.; breadth, 0.46 mm.

Collected by the writer at Arcola, Ill. Several specimens.

Oribata unimaculata Banks.

1906. *Galumna unimaculata*, Banks, Proc. Acad. Nat. Sci. Phila., Nov. 1906, p. 490, Pl. XVIII., Fig. 33.

Dark reddish brown; integument thick; surface smooth.

Lamellæ large, about two thirds as long as the cephalothorax, broader anteriorly than posteriorly; lamellar cusps prominent, slightly bifid in front, the long, straight, pectinate lamellar hairs extending from them; translamella about a third as broad as the lamellæ; anterior free edge concave. There are two pairs of tectopedia, of which the inner pair is the longer, extending forward almost as far as do the tips of the lamellar cusps, curved slightly toward the median plane, and bearing a pair of long, curved, pectinate bristles. The outer pair of tectopedia are much thicker and shorter than the inner pair and bear no bristles. Interlamellar hairs similar to lamellar hairs but longer. Pseudostigmatic organs short and clavate, about as long as the genual of leg I.

Abdomen subglobose, the dorsum bearing ten pairs of short, stout, slightly curved pectinate bristles; two pairs are situated just above the pteromorphæ, two pairs on the crown of the dorsum, two pairs are posterior in position, and four pairs occur around the margin of the abdomen. The pteromorphæ are attached to the anterior half of the side of the abdomen; are truncate in front, and do not extend beyond the anterior margin of the abdomen. Genital covers about three fourths as long as the anal covers and situated one and a half times their length in front of the latter.

Anterior pair of legs about two thirds as long as the body; tarsus and tibia subequal; genual more than half as long as the tibia. The tibia and genual of leg I each bear laterally a very stout, slightly curved enlarged spine. Genual of leg II with a similar spine. Ungues tridactyle.

Length, 0.80 mm.; breadth, 0.60 mm.

Under old boards. Collected by the writer at Arcola, Ill. Several specimens. Mr. Banks has confirmed this determination from a specimen sent him by the author.

Oribata turgida Banks.

1906. *Galumna turgida*, Banks, Proc. Acad. Nat. Sci. Phila., 1906, p. 493.

Very light brown; integument smooth.

Cephalothorax short and wide; lamellæ narrow, about half as long as the cephalothorax, broader at the anterior than at the posterior end; translamella equal to the lamellæ in width. Lamellar hairs long, straight and barbed, about one and a third times as long as the lamellae; interlamellar hairs slightly longer than the lamellar hairs; antero-lateral hairs about two thirds as long as the lamellar hairs and curved as usual. Pseudostigmatic organ short, subcapitate.

Abdomen about as broad as long, broadest near the middle, hairless. Pteromorphæ small, truncate anteriorly, and not extending beyond the anterior margin of the abdomen. Genital covers slightly over half as long as the anal covers and situated about twice their length in front of the latter.

Anterior pair of legs about as long as the abdomen. Tarsus and tibia of leg I subequal; genual about a third as long as the tibia; femur equal to tibia in length. At the distal end of tibia of leg I, there is a small tubercle from which extends a long tactile bristle, longer than the segment itself. Ungues tridactyle; dactyles almost equal.

Length, 0.50 mm.; breadth, 0.42 mm.

Shaken from elm and from papaw by C. A. Hart. at Muncie. Ill.

Oribata minuscula Banks.

1907. *Galumna minuscula*, Banks, Proc. Acad. Nat. Sci. Phila., Vol. LVIII., p. 492, Pl. XV., Fig. 11.

Dark reddish brown, legs paler; integument slightly rough, heavily chitinized.

Cephalothorax about three fifths as long as the abdomen; lamellæ large horizontal blades, anteriorly a fourth as broad as long and at the posterior end a mere line; translamella a small ridge. Lamellar hairs long, straight, and pectinate, about four fifths as long as the cephalothorax. Pseudostigmata circular and low, pseudostigmatic organ short. with a very short peduncle and a spherical head. Interlamellar hairs almost exactly like the lamellar hairs. Rostral hairs much shorter than these and slightly curved.

Abdomen as broad as long, hairless; pteromorphæ one fourth as broad as long, truncate anteriorly, extending backward half the length of the abdomen and not projecting much beyond the anterior margin; anal covers a third longer than the genital covers and situated about half their length from the posterior margin of the abdomen; genital covers situated about twice their length in front of the anal covers.

Legs subequal in length; femora of the last two pairs much enlarged, being two thirds as broad as long, tibia and tarsus subequal. At the distal end of the tibia on the first and the last pair of legs is situated a tactile hair slightly longer than the segment itself.

Length, 0.72 mm.; breadth, 0.52 mm.

Collected by myself at Urbana, Ill. Many specimens. The identification of this species has been confirmed by Mr. Banks from a specimen sent him by the author.

Oribata fuscipes C. L. Koch.

1835. *Zetes ephippiatus*, C. L. Koch, Crust. Myr. Arach., Heft 3, Tab. 7.
1884. *Oribata fuscipes*, Michael, Brit. Orib., Vol. I., p. 241, Pl. VII., Fig. 1, 2.
1895. *Oribatella bidentata* (?), Banks, Trans. Amer. Ent. Soc., Vol. XXII., p. 8.
1898. *Oribata fuscipes*, Michael, Das Tier., Lief. 3, p. 13.

Dark brown; integument thick and tough; surface almost smooth.

Cephalothorax short; lamellæ large, horizontal, twice as long as broad, truncate in front and bearing there a straight plumose hair as long as the lamellæ themselves; translamella a short blade; pseudostigmatic organ long, filiform, becoming stouter apically, almost erect.

Abdomen two thirds as broad as long, with a row of long, slightly curved bristles on the posterior margin and a few hairs on the sides. Pteromorphæ small, truncate in front. Anal covers situated about two thirds their length from the posterior margin of the abdomen; genital covers about two thirds as long as anal covers.

Legs subequal; a small blade present on each of the femora of the first two pairs; the tarsus of leg I with a long bristle near its proximal end; all the tarsi well clothed with hairs.

Length, 0.70 mm.; breadth, 0.44 mm.

Under boards and in moss. Collected by the writer at Arcola, Ill. Four specimens. A specimen of this species was sent to Michael, and he also identified it as *O. fuscipes*.

Oribata artilamellata, n. sp. (Pl. XXXIII., Fig. 2.)

Dark olive; integument of medium thickness, not very resistant, finely pitted.

Cephalothorax about a third as long as abdomen; lamellæ narrow blades on edge, of uniform width, with small cusps; translamella a narrow blade, about half as broad as the lamellæ; pseudostigmata cylindrical, longer than broad; pseudostigmatic

organ clavate and pectinate, recurved, and of medium length; interlamellar hairs subequal to lamellar hairs; rostral hairs much smaller than these and very slightly curved.

Abdomen large, almost spherical, hairless; pteromorphæ rudimentary; anal covers about twice as long as genital covers; genital covers situated about three times their length in front of anal covers.

Legs subequal; femur of leg I extending to tip of rostrum, tibia and tarsus subequal, genual a little less than half as long as the tibia.

Length, 0.70 mm.; breadth, 0.46 mm.

Collected by the author at Arcola, Ill. Several specimens.

Oribata arborea Banks.

1895. *Oribata arborea*, Banks, Trans. Amer. Ent. Soc., Vol. XXII., p. 7.

Light chestnut-brown; integument smooth.

Cephalothorax half as long as the abdomen, triangular; lamellæ long narrow blades, of about uniform width and about two thirds as long as the cephalothorax; lamellar hairs straight and apparently without barbs, about as long as the lamellæ; interlamellar hairs similar to lamellar hairs; antero-lateral hairs but slightly curved and about three fourths as long as the lamellar hairs. Pseudostigmata cup-shaped, slightly projecting; pseudostigmatic organ clavate, recurved, and very slightly barbed at the end.

Abdomen two thirds as broad as long, hairless; pteromorphæ truncate anteriorly and not extending beyond the anterior margin of the abdomen; anterior margin slightly emarginate above; genital covers almost as long as the anal covers but much narrower, situated about one and a half times their length in front of the latter.

Anterior pair of legs two thirds as long as the abdomen. Tarsus and tibia of leg I subequal; genual one half as long as the tibia. From a small tubercle on the distal end of the tibia of leg I extends a long tactile bristle, longer than the segment itself. Ungues tridactyle; dactyles unequal.

Length, 0.45 mm.; breadth, 0.30 mm.

Under bark. Collected by J. Douglas Hood at Muncie, Ill. One specimen.

Oribata virginica Banks. (Pl. XXXIV., Fig. 5.)

1906. *Galumna virginica*, Banks, Proc. Acad. Nat. Sci. Phila., Nov., 1906, p. 493, Pl. XVI., Fig. 18 and 20.

Walnut-brown; integument brittle; surface rough.

Cephalothorax about a third as long as the abdomen; lamellæ broad, blade-like, almost as long as the cephalothorax, broadest at the middle, each with blunt apex bearing the lamellar hair; lamellar hair straight, simple, about two thirds as long as the cephalothorax; pseudostigmata large, funnel-shaped; pseudostigmatic organ serrate, with long, thin, recurved peduncle and clavate head; interlamellar hairs long, thin, and pectinate; rostral hairs subequal to lamellar hairs and slightly curved; three pairs of tectopedia, the first pair blade-like and very narrow, the second and third pairs rounded.

Abdomen two thirds as broad as long, hairless; pteromorphæ very narrow, truncate in front, and extending about two thirds the length of the abdomen; anal covers triangular, fully twice as long as the genital covers; genital covers rectangular, small, and situated about twice their length in front of the anal covers.

Legs subequal, the anterior pair extending in front of the rostrum by about half their length.

Length, 0.50 mm.; breadth, 0.34 mm.

Under boards, bark, and logs, and in moss. Collected by the writer at Homer, Ill. Several specimens.

Oribata longa, n. sp. (Pl. XXXIV., Fig. 6.)

Light yellowish brown; integument rather thin; surface rough.

Cephalothorax short; lamellæ mere ridges; lamellar hairs rather short, pectinate, and slightly curved; pseudostigmata cup-shaped; pseudostigmatic organ long, recurved, lanceolate, and strongly serrate on the anterior edge only, the posterior

edge being smooth; interlamellar hairs short and pectinate, inclined away from the median plane; rostral hairs small and curved.

Abdomen twice as long as broad, hairless, dorsum irregularly covered with small denticles; pteromorphæ very long and narrow, truncate in front; anal covers very much enlarged, being twice as long as the genital covers; genital covers narrow and situated about twice their length in front of the anal covers.

Legs small, first pair projecting about one third their length beyond the rostrum.

Length, 0.54 mm.; breadth, 0.28 mm.

In moss. Collected by the writer at Homer, Ill. One specimen.

Oribata illinoisensis, n. sp. (Pl. XXXIII., Fig. 3.)

Olive brown; integument rather thick and tough, not very resistant, somewhat rough.

Cephalothorax about a fourth as long as abdomen; lamellæ broad horizontal blades about three fifths as long as the cephalothorax, broadest towards the middle, and with small cusps; lamellar hairs simple, straight, as long as the cephalothorax; three pairs of tectopedia, the first pair blade-like, the second large, rounded, and ending anteriorly in a long, sharp point, the third rounded; pseudostigmatic organ short and stout, with short peduncle and large, pectinate, clavate head; interlamellar hairs straight, pectinate, and about two thirds as long as the lamellar hairs; rostral hairs stout, curved, and pectinate.

Abdomen slightly longer than broad, hairless; pteromorphæ prominent, truncate in front, with concave anterior margin, and extending backward about two thirds the length of the abdomen; anal and genital covers subequal; anal covers situated about half their length from the posterior margin of abdomen; genital covers about one and a half times their length in front of the anal covers.

Legs small, with several stout plumose bristles; the two anterior pairs subequal, the first pair projecting half their length in front of the rostrum.

Length, 0.48 mm.; breadth, 0.34 mm.

Collected by the writer at Arcola, Ill. One specimen.

Oribata banksi, n. sp. (Fig. 2 and 3, pp. 339, 340.)

Dark chestnut-brown, integument heavily chitinized; surface pitted.

Cephalothorax about a third as long as the abdomen; lamellæ blade-like, about half as long as cephalothorax, broadest at the anterior end, without cusps; lamellar hairs straight, pectinate, and about as long as the cephalothorax; first pair of tectopedia very similar to lamellæ; second pair round, cup-like. Pseudostigmata cylindrical, distal end cup-shaped; pseudo stigmatic organ slightly recurved.

Abdomen two thirds as broad as long, the dorsum with four rows of long, curved, pectinate bristles, about five in each row; pteromorphæ large, truncate in front, not extending in front of the anterior margin of abdomen, but extending backward about half the length of the abdomen; anal and genital covers rectangular, the anal ones a third longer than the genital ones.

Legs stout; anterior pair about as long as the abdomen; third pair smallest; femur of leg I about two thirds as long as the cephalothorax.

Length, 0.54 mm.; breadth, 0.40 mm.

Under bark of dead trees and under rubbish of various kinds. Collected by the author at Galton, Arcola, and Homer, Ill., and by C. A. Hart from pitcher-plants (*Sarracenia purpurea*) in bog at Cedar Lake, Ill. Several specimens.

Family NOTHRIDÆ.

Cephalothorax and abdomen immovably fused or coalescing; body never compressed; tracheæ opening at the acetabula of the legs; abdomen without wings; integument frequently rough, sculptured, or reticulate, and sometimes very little chitinized; legs frequently very stout, sometimes long and moniliform.

Genus Liacarus Michael.

Mandibles chelate; legs I and II approximate, as also legs III and IV; lamellæ present; body smooth; last three pairs of legs inserted under the body.

KEY TO SPECIES.

1. Abdomen almond-shaped .... *lucidus*.
   Abdomen oval .... 2.
2. Color brown; integument thin and delicate .... *minutus*.
   Color black; integument thick and resistant .... 3.
3. Translamella with a central cusp .... *niger*.
   Translamella without a central cusp .... *nitidus*.

Liacarus lucidus, n. sp. (Pl. XXXIV., Fig. 9.)

Light pea-green; integument thin and brittle; surface smooth.

Cephalothorax long. Lamellæ two thirds as long as cephalothorax. They are blades on edge, of almost uniform width, and without cusps; lamellar hairs about as long as lamellæ, curved and pectinate; translamella similar to lamellæ but only about half as broad. Pseudostigmata funnel-shaped; pseudostigmatic organ stout, short, pectinate, clavate, and slightly recurved; interlamellar hairs subequal to lamellar hairs but inclined away from the median plane; palpi prominent.

Abdomen almond-shaped, dorsum with four rows of short, curved bristles, of which there are about six in each of the outer rows and four in each of the inner ones.

Legs short, subequal; femora slightly enlarged.

Length, 0.48 mm.; breadth, 0.28 mm.

Collected by the writer at Arcola, Ill. Several specimens.

Liacarus minutus, n. sp. (Pl. XXXV., Fig. 10.)

Brown; integument thin and delicate.

Cephalothorax rather short; lamellæ narrow, being mere blades on edge, two thirds as long as the cephalothorax, and each bearing a long, straight, pectinate lamellar hair, as long as the lamellæ themselves. Rostrum broad but somewhat

pointed at the apex; rostral hairs long, pectinate, curved slightly toward the median plane. Palpi large, with four segments; proximal and distal segments each with a curved bristle; pseudostigmata small; pseudostigmatic organ as long as the femur of leg I, narrow at the base, clavate, pointed apically. Interlamellar hairs twice as long as the pseudostigmatic organ.

Abdomen almost as broad as long. The progaster curves convexly down to meet the cephalothorax. There are a few short hairs present on the abdomen. Ventral plate large; anal covers approximate to the dorsal margin of the abdomen, and more than twice as large as the genital covers; genital covers situated three times their length in front of the anal covers.

Legs subequal in length; femur and tarsus of the first pair subequal, genual half as long as the tibia. No long bristles on the first pair of legs; tibia of leg III with a bristle as long as the segment itself.

Length, 0.50 mm.; breadth, 0.32 mm.

Collected by the writer at Urbana, Ill. A single specimen.

Liacarus niger, n. sp. (Pl. XXXV., Fig. 11.)

Black; integument thick and very resistant.

Cephalothorax about half as long as the abdomen. Lamellar hairs long, straight, and pectinate, projecting beyond the tip of the rostrum. Rostral hairs curved, stout, and pectinate. Pseudostigmatic organ long, clavate, and pectinate. The lamellæ are horizontal blades, bifid in front.

Abdomen oblong, with a few small hairs. Legs of moderate length, the anterior pair projecting beyond the tip of the rostrum by one third its length.

Length, 1.00 mm.; breadth, 0.64 mm.

In moss. Collected by the writer at Homer, Ill. Two specimens.

Liacarus nitidus Banks.

1895. *Cepheus nitidus*, Banks, Trans. Amer. Ent. Soc., Vol. XXII., p. 10.

Very dark brown; integument stout, smooth.

Cephalothorax pyramidal. Lamellæ blade-like, broad, extending almost the entire length of the cephalothorax and united at their anterior ends by a very short but broad translamella; with small cusps. Lamellar hairs small, straight, about three fifths as long as the lamellæ; interlamellar hairs similar to the lamellar ones but slightly larger; antero-lateral hairs about as long as the lamellar ones and almost straight. Pseudostigmatic organ fusiform, about two thirds as long as the lamellæ.

Abdomen subglobose; hairless. Genital covers much smaller than the anal covers; anal covers slightly broader posteriorly than anteriorly, and situated one third their length from the posterior margin of the ventral plate.

Anterior pair of legs about as long as the abdomen. Tarsus and tibia of leg I subequal; genual about three fifths as long as the tibia; femur almost twice as long as the genual. Tactile bristle of tibia I about as long as the segment itself. Claws with three equal dactyles, and situated on small tarsal pedicels.

Length, 0.88 mm.; breadth, 0.72 mm.

Collected by the writer at Arcola, Ill.

Genus Notaspis Hermann.

Integument well chitinized; cephalothorax with lamellæ; body smooth; last three pairs of legs situated laterally.

KEY TO SPECIES.

1. Abdomen without hairs .... *pyrostigmata*.
   Abdomen with hairs.. 2.
2. Outer margins of lamellæ slightly emarginate near middle; length of body not over 0.60 mm................... *spinipes*.
   Outer margins of lamellæ straight; length of body about 0.90 mm.. *bipilis*.

Notaspis pyrostigmata, n. sp. (Pl. XXXV., Fig. 12.)

Very light yellowish brown; surface of integument rough.

Cephalothorax long; lamellæ narrow blades, broadest at the anterior ends; lamellar hairs about half as long as the

cephalothorax, slightly curved, pectinate; translamella a straight cross-bar; pseudostigmata cup-shaped; pseudostigmatic organ with a small short peduncle and a large pyriform head; interlamellar hairs of medium length, straight, and pectinate.

Abdomen almond-shaped, hairless; anal covers contiguous to the posterior margin of the abdomen; genital covers two thirds as long as the anal covers, and situated about three times their length in front of them.

Hind pair of legs longest, but not reaching to the posterior margin of the abdomen; the other pairs subequal.

Length, 0.42 mm.; breadth, 0.20 mm.

Collected by the writer at Arcola, Ill. Many specimens.

Notaspis spinipes Banks.

1906. *Oppia spinipes*, Banks, Proc. Acad. Nat. Sci. Phila., Nov., 1906, p. 496, Pl. XVII., Fig. 22.

Chestnut brown; surface of integument smooth.

Cephalothorax very long and narrow, almost as long as the abdomen; lamellæ very long, narrow, their blades extending the entire length of the cephalothorax; lamellar cusps prominent, pectinate, straight, and short; pseudostigmatic organ long, straight, and pectinate; interlamellar hairs straight, pectinate, pointing almost directly forward; rostral hairs small, simple, and curved.

Abdomen circular, with two pairs of large, straight, pectinate spines on the dorsal margin; anal covers about the same size as the genital covers and contiguous to the posterior margin of the abdomen.

Legs subequal, with several stout, curved, plumose bristles; tactile hairs on the tibiæ of the first two pairs about twice as long as the segments themselves.

Length, 0.56 mm.; breadth, 0.34 mm.

In moss. The author has collected specimens at Arcola, Ill. The determination has been confirmed by the original describer of the species.

Notaspis bipilis Herm.

1804. *Notaspis bipilis*, Hermann, Mém. Apt., p. 95.
1841. *Murcia acuminata*, C. L. Koch, Crust. Myr. Arach., Heft 31, Tab. 24 (Nymph).
1844. *Oppia cornuta*, C. L. Koch, Crust. Myr. Arach., Heft 38, Tab. 8.
1855. *Notaspis bipilis*, Nicolet, Arch. Mus. Paris, Vol. VII., p. 448, Pl. III., Fig. 6.
1883. *Notaspis bipilis*, Berlese, Bull. Soc. Ent. Ital., Vol. XV., p. 219.
1885. *Oppia bipilis*, Berlese, Acari, Myr., Scorp., Fasc. XX., Nr. 8.
1888. *Notaspis bipilis*, Michael, Brit. Orib., Vol. II., p. 356, Pl. XXVII., Fig. 1–9.
1898. *Notaspis bipilis*, Michael, Das Tier., Lief. 3, p. 46.

Chestnut brown; integument smooth.

Cephalothorax large, one half as long as the entire body. Lamellæ very long and slender, almost as long as the entire body and of almost the same width throughout; anterior two fifths of lamellæ free. There is only a slight indication of a translamella. Lamellar hairs straight, pectinate, about half as long as the lamellæ; interlamellar hairs very large, as long as the entire cephalothorax, pectinate, and situated at the posterior margin of the latter; antero-lateral hairs straight, similar to lamellar hairs but smaller. Pseudostigmata but slightly projecting, funnel-shaped; pseudostigmatic organ long, filiform, pectinate.

Abdomen globose, bearing on its postero-dorsal aspect two pairs of large, straight bristles, and on its postero-ventral aspect a transverse row of four subequal straight ones, about half as long as the dorsal bristles. Genital covers semicircular, situated slightly more than their length from the anal covers; anal covers much larger than the genital covers, and situated about a third their length from the posterior margin of the ventral plate.

Anterior pair of legs about as long as the entire body; tarsus one and a half times as long as the tibia; tactile bristle of tibia straight, as long as the tarsus. Claws of tarsi with three unequal dactyles.

Length, 0.90 mm.; breadth, 0.68 mm.

In moss. Collected by L. M. Smith at Parker, Ill., and by the writer at Arcola, Ill. My determination of this species has been confirmed by a comparison of my specimens with a mounted one of *bipilis* sent me by Michael.

Genus *Tegeocranus* Nicolet.

Body rough; cephalothorax and abdomen plainly divided; ungues monodactyle; lamellæ large, blade-like.

Two species:

Integument granular.............................. *velatus*.
Integument reticulate........................... *lamellatus*.

Tegeocranus velatus Michael.

1880. *Tegeocranus velatus*, Michael, Jour. Roy. Micr. Soc., Vol. III., p. 189, Pl. VI., Fig. 6-9.
1884. *Tegeocranus velatus*, Michael, Brit. Orib., Vol. I., p. 313, Pl. XXXI., Fig. 9-15.
1895. *Tectocepheus velatus*, Berlese, Acari, Myr., Scorp., Fasc. LXXVII., Nr. 2.
1898. *Tegeocranus velatus*, Michael, Das Tier., Lief. 3, p. 35.

Light brown; integument coarsely granular.

Cephalothorax trapezoidal. Lamellæ almost as long as the cephalothorax, the anterior lamella one third free; translamella reduced almost to a line. Lamellar hairs short, stout, and pectinate on their outer borders only, peculiar in that they are so greatly curved inward that their tips may touch; interlamellar hairs wanting. Pseudostigmata cup-shaped, slightly projecting; pseudostigmatic organ subcapitate, with a long pectinate head.

Abdomen almost as broad as long and peculiar in possessing a lateral, chitinous, shelf-like expansion at the shoulders, which extends backward along the lateral margin to about the middle of the abdomen, and is transversely wrinkled. Genital covers much smaller than the anal covers, and situated about their length from the latter; anal covers situated about a third their length from the posterior margin of the abdomen.

Legs rather short, subequal, about three fourths as long as the abdomen, sparsely clothed with rather short, stout hairs. Tibia slightly longer than the tarsus; claw of tarsus stout, two thirds as long as the segment itself.

Length, 0.38 mm.; breadth, 0.30 mm.

In moss. Collected by the writer at Muncie, Ill.

Tegeocranus lamellatus Banks.

1906. *Cepheus lamellatus*, Banks, Proc. Acad. Nat. Sci. Phila., 1906, p. 497.

Very dark brown, almost black; integument strengthened with an irregular network of chitinous ridges.

Cephalothorax short, broad. Lamellæ very large, each about half as broad as the cephalothorax and extending almost the entire length of the latter; lamellæ united in front by a very short, broad translamella. Lamellar hairs stout, curved strongly inward, about two thirds as long as the lamellæ; interlamellar hairs very short, almost straight, and approximate to the lamellæ. Pseudostigmata cup-shaped, projecting; pseudostigmatic organ consisting of a stout, straight pedicel with a small, oblong, pectinate head.

Abdomen almost as broad as long, semicircularly rounded behind. Dorsum with rather stout shoulder bristles and with several other bristles at the posterior end. Genital covers slightly smaller than the anal covers, and situated about half their length from the latter; anal covers situated their length from the posterior margin of the abdomen.

Anterior pair of legs three fourths as long as the abdomen. Tarsus of leg I one and a half times as long as the tibia. Tarsal claws stout, sharp, and strongly curved. Legs sparsely clothed with long straight bristles.

Length, 0.76 mm.; breadth, 0.66 mm.

In moss. Collected by the writer at Arcola, Ill. One specimen.

Genus Damæus C. L. Koch.

Mandibles chelate; legs slender, much longer than the body, I and II approximate, as also III and IV; legs IV crawling organs; lamellæ absent; cephalothorax and abdomen clearly demarcated from each other.

Two species:

Pseudostigmatic organ simple, not pectinate......... *sufflexus*.
Pseudostigmatic organ pectinate........................ *nitens*.

Damaeus sufflexus Michael.

1885. *Damaeus sufflexus*, Michael, Jour. Roy. Micr. Soc., Ser. 2, Vol. V., p. 394, Pl. VII., Fig. 9.
1888. *Damaeus sufflexus*, Michael, Brit. Orib., Vol. II., p. 415, Pl. XXXIV., Fig. 9, 10.
1895. *Belba sufflexa*, Berlese, Acari, Myr., Scorp., Fasc. LXXIV., Nr. 4.
1898. *Damaeus sufflexus*, Michael, Das Tier., Lief. 3, p. 58.

Light brown, legs almost yellow; integument of cephalothorax rather rough, abdomen smooth.

Cephalothorax subrectangular, pointed at apex, with a rather large boss under each pseudostigma. Lamellar hairs absent; rostral hairs stout, slightly curved. Pseudostigmata long, nearly upright, cylindrical; pseudostigmatic organ filiform, very long, about equal in length to the cephalothorax.

Abdomen globular; progaster rounded; notogaster with a row of about five short, stout, slightly curved hairs on each side, which project slightly beyond the side of the abdomen. Ventral plate small; anal and genital covers of almost exactly the same size and form, with a very narrow margin between them.

Legs rather long, of medium thickness, and typical of the genus. Femur of leg I twice as long as the genual, and with two large bristles on the outer distal margin; genual two thirds the length of the tibia; tibia two thirds the length of the tarsus; tarsus globose proximally and tapering distally, with a very stout bristle on the outer proximal margin.

Length, 0.70 mm.; breadth, 0.42 mm.

Under logs. Collected by the writer at Urbana, Ill.

Damaeus nitens C. L. Koch. (Fig. 1, p. 339.)

1834. *Oppia nitens*, C. L. Koch, Crust. Myr. Arach., Heft 3, Tab. 10.
1888. *Damaeus nitens*, Michael, Brit. Orib., Vol. II., p. 409, Pl. XXXIV., Fig. 1-8.
1895. *Belba minuta*, Banks, Trans. Amer. Ent. Soc., Vol. XXII., p. 12.
1898. *Damaeus nitens*, Michael, Das Tier., Lief. 3, p. 57.

Light yellowish brown; integument polished.

Rostrum broad, about a third the length of the cephalothorax; translamella absent; pseudostigmata very small; pseu-

dostigmatic organ slender, pectinate, and clavate. The general shape of the cephalothorax is that of an isosceles triangle with its base corresponding to that of the cephalothorax.

Abdomen oval, with about twelve short, slightly curved bristles; progaster curved down convexly to meet the cephalothorax. Ventral plate large; anal covers large, almost attaining the posterior margin of the abdomen, and about twice their length from the genital covers, which are about three fourths as long as the anal covers and situated very near the anterior margin of the ventral plate.

First pair of legs almost as long as the body, and each succeeding pair slightly longer than the preceding one. Tarsus of the first pair of legs somewhat globose at the distal end; coxæ of the third pair globular, each bearing a large bristle on its anterior end; tibiæ of fourth pair each bearing on the anterior distal margin a large bristle as long as the tibia itself.

Length, 0.50 mm.; breadth, 0.28 mm.

Collected by the writer at Urbana, Ill. Many specimens. I find that my examples of this species agree with a European specimen of *nitens* sent to me by Mr. Michael.

Genus Hermannia Nicolet.

Without lamellæ; legs short and stout; ungues monodactyle; dorsum of abdomen convex; genital and anal covers separate and placed in a ventral plate.

One species—*bistriata*.

Hermannia bistriata Nicolet.

1840. *Nothrus palliatus*, C. L. Koch, Crust. Myr. Arach., Heft 30, Tab. 4 (Nymph).

1880. *Hermannia bistriata*, Michael, Jour. Roy. Micr. Soc., Vol. III., p. 42.

1885. *Nothrus bistriatus*, Berlese, Acari, Myr., Scorp., Fasc. XVII., Nr. 9.

1888. *Hermannia bistriata*, Michael, Brit. Orib., Vol. II., p. 462, Pl. XLII., Fig. 8-14.

1898. *Hermannia bistriata*, Michael, Das Tier., Lief. 3, p. 63.

Dark chestnut-brown; integument rough, and in some places slightly pitted.

Cephalothorax fully half as long as the abdomen, with two chitinous ridges on the dorsal surface, which, beginning at the

rostrum, pass backward almost parallel to each other for about one half the length of the cephalothorax, then diverge, passing to the outer border of the pseudostigmata, with which they fuse, and from the posterior border of which they turn transversely toward the median plane, where they meet. There is a single pair of stout hairs on the dorsal surface at the base of the rostrum, which are curved towards the median plane. Pseudostigma a circular chitinous ridge; pseudostigmatic organ straight, slightly clavate, and directed anteriorly.

Abdomen subrectangular, two thirds as broad as long, sides convex, posterior end rounded. An irregular chitinous ridge lies on each side near the median plane; about midway between this ridge and the lateral margin of the abdomen is situated on each side a more regular chitinous ridge which curves similarly toward the lateral margin. There are several short, curved bristles on the lateral margins, two rows parallel to the median plane, and six rather prominent pairs near the posterior margin, all of which curve inward. Ventral plate triangular, genital and anal covers together extending almost its entire length.

Anterior pair of legs about as long as the abdomen. Tarsus of leg I longer than the tibia but not so stout; claw of tarsus almost half as long as the segment itself. All the segments of the legs except the tarsus possess stout, curved bristles. The bristles of the tarsus are slender and more numerous than those of the other segments.

Length, 0.85 mm.; breadth, 0.48 mm.

Under logs and in moss. Collected by J. Douglas Hood at Urbana, Ill., and by the writer at Arcola, Ill.

Genus Hypochthonius C. L. Koch.

Mandibles chelate; last pair of legs not distant from the others; integument thin, little chitinized, variously colored; abdomen with a transverse suture; cephalothorax not truncate in front.

One species,—*rufulus*.

Hypochthonius rufulus C. L. Koch.

1835. *Hypochthonius rufulus*, C. L. Koch, Crust. Myr. Arach., Heft 3, Tab. 19.
1855. *Leisoma ovata*, Nicolet, Arch. Mus. Paris, T. VII., p. 395, Pl. II., Fig. 5 (Nymph).
1888. *Hypochthonius rufulus*, Michael, Brit. Orib., Vol. II., p. 534, Pl. XLIX., Fig. 6–13.
1898. *Hypochthonius rufulus*, Michael, Das Tier., Lief. 3, p. 77.

Body reddish; legs brown.

Cephalothorax very long,two thirds as long as the abdomen. Pseudostigmata short, cylindrical; pseudostigmatic organ long and recurved, with a row of long teeth on the anterior side; a pair of long bristles, almost as long as the pseudostigmatic organ itself, in front of the pseudostigmata; palpi very prominent

Abdomen broad, divided by a transverse suture into two equal parts; flattened at the sides, forming blades which extend almost the entire length of the abdomen; many large bristles.

Legs short, stout, and subequal; segments cylindrical.

Length, 0.66 mm.; breadth, 0.40 mm.

Collected by the writer at Arcola, Ill. Two specimens.

Family HOPLODERMIDÆ.

Cephalothorax hinged to the abdomen and capable of being folded down upon its ventral surface so as completely to hide the legs and mouth-parts; body generally compressed; no tracheæ present; mouth-parts large, mandibles powerful; legs stout, never with swollen or moniliform segments; cephalothorax frequently with a median carina.

Genus Hoploderma Michael.

Genital and anal openings situated together but with their covers separate; ventral plate small or rudimentary; ungues monodactyle.

Two species:

Total length of body not over 0.60 mm. . . . . *sphærula.*
Total length of body over 1.00 mm . . . . *dasypus.*

Hoploderma sphærula Banks.

1895. *Hoploderma sphærula*, Banks, Trans. Amer. Ent. Soc., Vol. XXII., p. 16.

Dark brown; integument smooth.

Cephalothorax one half as long as high; dorsal surface with two pairs of bristles,—a very long, almost straight pair, three fourths as long as the cephalothorax itself, situated near the posterior border, and a small, curved pair near the tip. Pseudostigmata round, situated at the postero-lateral extremity of the cephalothorax; pseudostigmatic organ slightly recurved.

Abdomen subglobose; upper half of the anterior margin concave, lower half straight; ventral margin moderately convex; dorsum with two rows of submedian bristles, six bristles in each row. Genito-anal covers almost completely concealed when viewed from the side, the anterior corner, however, visible as a triangular chitinous projection.

Anterior pair of legs stouter than the other pairs, which are subequal. Tarsus of leg I nearly twice as long as the tibia; tibia slightly longer than the genual; femur longer than the tibia and genual combined. Claws slightly more than half as long as the tarsi from which they extend. All the legs are sparsely clothed with rather long, simple bristles.

Length, 0.55 mm.; height, 0.40 mm.

Under a log. Collected by the writer at Mahomet, Ill.

Hoploderma dasypus Ant. Dugès.

1834. *Oribata dasypus*, Ant. Dugès, Ann. Sci. Nat., Sér. 2, T. II., p. 47.
1841. *Hoplophora lentula*, C. L. Koch, Crust. Myr. Arach., Heft 32, Tab. 16.
1841. *Phthiracarus contractilis*, Perty, Allg. Naturg., Bd. III., p. 874.
1868. *Hoplophora contractilis*, Claparède, Zeit. Wiss. Zool., Bd. XVIII., p. 507.
1877. *Hoplophora contractilis*, Murray, Econ. Ent., Apt., p. 222.
1883. *Hoplophora dasypus*, Berlese, Acari, Myr., Scorp., Fasc. VI., Nr. 4.
1885. *Hoplophora dasypus*, Canestrini, Prosp. Acar. Ital., Pt. I., p. 46.
1887. *Tritia lentula*, Berlese, Acari, Myr., Scorp., Fasc. XXXVI., Nr. 3.
1888. *Hoplophora dasypus*, Michael, Brit. Orib., Vol. II., p. 560, Pl. L., Fig. 8–14.
1898. *Hoploderma dasypus*, Michael, Das Tier., Lief. 3, p. 79.

Pale drab; integument thick and tough but not brittle.

Cephalothorax a fourth as long as abdomen, with a single

pair of small hairs; pseudostigmatic organ small, scarcely visible, clavate, and simple. Palpi and labial organs prominent.

Abdomen almost as broad as long, rounded behind, with three rows of long bristles on each side of the dorsum, the inner row having the largest bristles; three bristles in each of the outer rows.

Legs subequal, with many long hairs.

Length, 0.84 mm.; height, 0.56 mm.

In decayed wood. Collected by myself at Arcola, Ill. A specimen of this species was sent to Michael to get his confirmation of the identification. He writes that my specimen agrees with *dasypus* except that it has no hairs on the abdomen. These hairs had evidently been broken off, as they are present on the other specimens which I have.

Genus Phthiracarus Perty.

The characters are the same as for the genus *Hoploderma* except that the genital and anal covers coalesce and the tarsal claws are tridactyle.

Two species:

Cephalothorax hairless........................ *flagelliformis.*
Cephalothorax with six long hairs............... *americanus.*

Phthiracarus flagelliformis, n. sp. (Pl. XXXV., Fig. 13.)

Dark olive-brown; integument thick but not brittle; surface rough.

Cephalothorax about a third as long as the abdomen, hairless; pseudostigmata round and flat, with radiating furrows; pseudostigmatic organ flagelliform and of moderate length; labial organs and palpi prominent.

Abdomen two thirds as broad as long, pointed at the posterior end, and with a few fine hairs. Legs subequal, clothed with many hairs.

Length, 0.72 mm.; height, 0.40 mm.

Under logs. Collected by myself at Homer, Ill. A few specimens.

Phthiracarus americanus, n. sp. (Pl. XXV., Fig. 14.)

Pale pinkish brown; integument well chitinized and covered with small pits.

Cephalothorax twice as long as broad; mandibles very stout and prominent, capable of retraction until invisible; pseudostigmatic organ clavate, of medium length. From each pseudostigma a ridge runs forward along the side of the aspis to its lateral edge. A pair of hairs about two thirds as long as the cephalothorax is situated at its posterior margin, and in front of this pair is a similar one, the hairs about two thirds as long; rostral hairs about two thirds as long as this last pair.

Abdomen about three fifths as broad as long and very narrow, pointed behind, truncate in front, covered with small pits. The dorsum has four rows of long, slightly curved bristles, about five in each row; and there are four pairs of short, straight bristles on the posterior ventral surface.

Legs subequal, as long as cephalothorax; claws tridactyle, and half as long as the tarsi; tarsus twice as long as the tibia, and with many long hairs. The tarsus of leg I bears a long tactile bristle half as long again as the tarsus itself; tibia and genual subequal.

This species differs from *Phthiracarus arduus* in that the pseudostigmatic organ is much shorter and clavate, while on the side of the aspis there is only one ridge instead of two.

Length, 0.70 mm.; height, 0.36 mm.

Under logs and boards. Collected by the writer at Danville, Arcola, and Urbana, Ill. Many specimens.

A LIST OF THE KNOWN NORTH AMERICAN SPECIES OF ORIBATOIDEA.

In the following list the same natural order is observed with respect to the families and genera as is used in the preceding keys and descriptions, but the species are arranged alphabetically. The single citation for genus or species is to the original description. All the known habitats and localities are given.

Family ORIBATIDÆ.

Genus PELOPS C. L. Koch.

Pelops C. L. Koch. Crust. Myr. Arach., Heft 2, 1835.

P. americanus Ewing. Psyche, Vol. XIV., p. 111.
In moss, Batavia, Ill.

Genus GYMNOBATES Banks.

Gymnobates Banks. Can. Ent., Vol. XXXIV., 1902, p. 175.

G. glaber Banks. Can. Ent., Vol. XXXIV., 1902, p. 176.
From dry gall, Washington, D. C.

Genus ORIBATODES Banks.

Oribatodes Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 10.

O. mirabilis Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 10.
In rotten debris, Sea Cliff, N. Y.

Genus ORIBATELLA Banks.

Oribatella Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 8.

O. aquatica Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 9.
On aquatic plants, Sea Cliff, N. Y.

O. borealis Banks. Insects, etc., Commander Isl., 1899, p. 349.
Glinka, Commander Isl.

O. minuta Banks. Trans. Amer. Ent. Soc., Vol. XXIII., 1896, p. 76.
Under bark, Sea Cliff, N. Y.

O. obesa Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 9.
Olympia, Wash.

O. ovalis C. L. Koch (*Oribates*). Crust. Myr. Arach., Heft 3, Tab. 5.
Under old boards, Arcola, Ill.

O. perfecta Banks. Trans. Amer. Ent. Soc., Vol. XXIII., 1896, p. 75.
Swept from low herbage, Pine Island, N. Y.; Norfolk, Va.

O. quadridentata Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 8.
Under boards, Urbana, Ill.; Sea Cliff, N. Y.

O. setosa Banks. Jour. N. Y. Ent. Soc., 1895, p. 129.
From wet *Sphagnum*, Roslyn, N. Y.

O. signata Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 9.
Sea Cliff, N. Y.

Genus ORIBATA Latreille.

This is the *Oribata* used in Michael's "Oribatidæ" (Das Tier., Lief. 3). Since the publication of that work in 1898 Dr. A. C. Oudemans has stated that the *Oribata* of Latreille is not, in his opinion, the *Oribata* of "Das Tierreich", but is a *Damæus*, and he gives the name *Notaspis* Herm. to this genus.

O. affinis Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 6.
Under loose bark, Washington, D. C.

O. alata Packard. Cave Memoir, 1887, p. 42.
Dixon's Cave, Ky.

O. americana Haller. Arch. Naturg., Jahrg. 50, Bd. I., p. 222, Taf. XV., Fig. 4.
America.

O. arborea Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 7.
On cedar- and peach- trees, Sea Cliff, N. Y.

O. armipes Banks (*Galumna*). Proc. Acad. Nat. Sci. Phila., 1906, p. 492.
Falls Church, Va., and Fort Lee, N. J.

O. artilamellata, n. sp.
Arcola, Ill.

O. banksi, n. sp.
Under bark of trees, Martinsville, Marshall, Urbana, and Havana, Ill.; in moss, Arcola, Ill.

O. centro-americana Stoll. Biol. Centr. Amer., Arach. Acar., p. 24, Pl. XV., Fig. 1.
British Honduras.

O. clavilanceolata Ewing. Psyche, Vol. XIV., p. 112.
Under stones, Batavia, Ill.

O. clavipectinata Ewing. Psyche, Vol. XIV., p. 112.
In moss, near Chicago, Ill.

O. curva Ewing. Psyche, Vol. XIV., p. 113.
Under logs, near Chicago, Ill.

O. depressa Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 6.
Sea Cliff, N. Y.

O. emarginata Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 7.
Under old logs, Urbana, Arcola, and Marshall, Ill.; in moss, Sea Cliff, N. Y.; Brazos county, Texas.

O. fuscipes C. L. Koch. Crust. Myr. Arach., Heft 6, Tab. 8.
In moss, New York State(?); under old pieces of wood, Arcola, Ill.

O. hirsuta Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 7.
Under dead leaves, Sea Cliff, N. Y.

O. illinoisensis, n. sp.
Arcola, Ill.

O. imperfecta Banks (*Galumna*). Proc. Acad. Nat. Sci. Phila., 1906, p. 492.
Indianapolis, Ind.

O. magna Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 6.
Sea Cliff, N. Y.

O. minuscula Banks (*Galumna*). Proc. Acad. Nat. Sci. Phila., 1906, p. 492.
From young peach- and apple- trees, Alma, Ill.; Bay Ridge, Md.

O. mœsta Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 6.
On the ground, Sea Cliff, N. Y.

O. multipilosa Ewing. Psyche, Vol. XIV., p. 113.
Under logs, near Chicago, Ill.

O. nitidula Banks (*Galumna*). Proc. Acad. Nat. Sci. Phila., 1906, p. 491.
Franconia, N. H.

O. octopunctata, n. sp.
In moss, Homer, Ill.

O. pallida Banks (*Oribatula*). Proc. Acad. Nat. Sci. Phila., 1906, p. 494.
Fort Lee, N. J.

O. palustris Banks. Jour. N. Y. Ent. Soc., 1895, p. 128.
From wet *Sphagnum*, Roslyn, N. Y.

O. parvilamellata, n. sp.
Homer, Ill.

O. persimilis Banks (*Galumna*). Proc. Acad. Nat. Sci. Phila., 1906, p. 491.
Franconia, N. H.

O. pratensis Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 6.
On grass, Sea Cliff, N. Y.

O. robusta Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 7.
Under bark of walnut, Urbana, Ill.; Sea Cliff, N. Y.; Fort Lee, N. J.; Washington, D. C.

O. rugifrons Stoll. Biol. Centr. Amer., Arach. Acar., p. 25, Pl. XV., Fig. 2.
British Honduras.

O. slossonæ Banks (*Galumna*). Proc. Acad. Nat. Sci. Phila., 1906, p. 490.
Franconia, N. H.

O. spinogenuala, n. sp.
Arcola, Ill.

O. texana Banks (*Galumna*). Proc. Acad. Nat. Sci. Phila., 1906, p. 494.
San Antonio, Tex.

O. turgida Banks (*Galumna*). Proc. Acad. Nat. Sci. Phila., 1906, p. 493.
Palm Springs, Calif.

O. unimaculata Banks (*Galumna*). Proc. Acad. Nat. Sci. Phila., 1906, p. 490.
Under boards, Arcola, Ill.; Franconia, N. H.

O. virginica Banks (*Galumna*). Proc. Acad. Nat. Sci. Phila., 1906, p. 493.
Under old pieces of wood and under bark, Homer, Ill.; Falls Church, Va.

Family NOTHRIDÆ.

Genus Liacarus Michael.

Liacarus Michael. Das Tier., Lief. 3, 1898, p. 40.

L. abdominalis Banks. Proc. Acad. Nat. Sci. Phila., 1906, p. 495.
Claremont, Calif.

L. carolinensis Banks. Proc. Acad. Nat. Sci. Phila., 1906, p. 494.
Black Mountain, N. C.

L. frontalis Banks. Proc. Acad. Nat. Sci. Phila., 1906, p. 495.
Falls Church, Va.

L. globifer P. Kramer (*Leisoma*). Bibl. Zool., Vol. XX., 1897, p. 80.
Greenland.

L. lucidus, n. sp.
Arcola, Ill.

L. minutus, n. sp.
Urbana, Ill.

L. modestus Banks. Proc. Calif. Acad. Sci., Ser. 3, Vol. III., 1904, p. 367.
Los Angeles, Calif.

L. niger, n. sp.
In moss, Homer, Ill.

L. nitidus Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 10.
Quite common on ground under wood, bark, stones, etc., Sea Cliff, N. Y.; Fort Lee, N. J.

Genus Notaspis Hermann.

Notaspis Hermann. Mém. Apterol., 1804, p. 87.

N. arctica Banks (*Eremæus*). Insects, etc., Commander Isl., 1899, p. 349.
Glinka, Commander Isl.

N. burrowsi Mich. Proc. Zool. Soc. Lond., 1890, p. 418, Pl. XXXVII., Fig. 1–4.
Lake Winnipeg, Canada.

N. canadensis Banks (*Oppia*). Proc. Acad. Nat. Sci. Phila., 1906, p. 497.
Ottawa, Canada.

N. carbonaria Banks. Proc. Acad. Nat. Sci. Phila., 1906, p. 496.
Humboldt, Calif.

N. floridana Banks (*Eremæus*). Proc. Acad. Nat. Sci. Phila., 1904, p. 145.
Punta Gorda, Fla.

N. montana Banks (*Oppia*). Proc. Acad. Nat. Sci. Phila., 1906, p. 497.
Franconia, N. H.

N. pilosa Banks (*Scutovertex*). Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 11.
Under bark of trees. Sea Cliff, N. Y.; Fort Lee, N. J.

N. punctulata Banks (*Cepheus*). Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 10.
In decaying fungus and in weeds, Sea Cliff, N. Y.

N. pyrostigma, n. sp.
Arcola, Ill.

N. spinipes Banks (*Oppia*). Proc. Acad. Nat. Sci. Phila., 1906, p. 496.
Falls Church, Va.

Genus Scutovertex Michael.

Scutovertex Michael. Jour. Roy. Micr. Soc., Vol. II., 1879, p. 241.

S. marinus Banks (*Nothrus*). Trans. Amer. Ent. Soc., Vol. XXIII., 1896, p. 77.
On rocks between tide marks, Sea Cliff, N. Y.

S. petrophagus Banks. Ent. News, Vol. XVII., 1906, p. 194.
In cavities in the surface of wet rock, Traghanic [Taughannock?] Falls, N. Y.

Genus Tegeocranus Nicolet.

Tegeocranus Nicolet. Arch. Mus. Paris, T. VII., 1855, p. 464.

T. lamellatus Banks (*Cepheus*). Proc. Acad. Nat. Sci. Phila., 1906' p. 497.
Falls Church, Va.

Genus Carabodes C. L. Koch.

Carabodes C. L. Koch. Crust. Myr. Arach., Heft 3, 1835.

C. apicalis Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 13.
Sea Cliff, N. Y.

C. brevis Banks. Trans. Amer. Ent. Soc., Vol. XXIII., 1896, p. 77.
Dead fungus, Sea Cliff, N. Y.

C. dorsalis Banks. Trans. Amer. Ent. Soc., Vol. XXIII., 1896, p. 77.
Sea Cliff, N. Y.

C. granulatus Banks. Jour. N. Y. Ent. Soc., 1895, p. 129.
From wet *Sphagnum*, Roslyn, N. Y.

C. niger Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 12.
In decaying fungi and under bark, Sea Cliff, N. Y.

C. oblongus Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 13.
Under bark, Sea Cliff, N. Y.

Genus Damæus C. L. Koch.

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In dead leaves, Mt. Vernon, Va.

D. australis Banks (*Belba*). Trans. Amer. Ent. Soc., Vol XXII., 1895, p. 12.
Shreveport, La.

D. bulbipedatus Packard. Cave Memoir, 1887, p. 42.
End of Dixon's Cave, Ky.

D. californicus Banks (*Oribata*). Proc. Calif. Acad. Sci., Ser. 3, Vol. III., 1904, p. 367.
Mt. Shasta, Calif.

D. floridanus Banks (*Belba*). Trans. Amer. Ent. Soc., Vol. XXIII., 1896, p. 76.
Punta Gorda, Fla.

D. longiseta Banks (*Oribata*). Proc. Acad. Nat. Sci. Phila., 1906, p. 498.
Falls Church, Va.

D. nitens C. L. Koch (*Oppia*). Crust. Myr. Arach., Heft 3, Tab. 10.
Urbana, Ill.

D. puritanicus Banks (*Oribata*). Proc. Acad. Nat. Sci. Phila., 1906, p. 498.
Middlesex Fells, Mass.

D. sufflexus Michael. Jour. Roy. Micr. Soc., Ser. 2, Vol. V., 1885, p. 394.
In moss, Dedham, Mass.

Genus Hermannia Nicolet.

Hermannia Nicolet. Arch. Mus. Paris, T. VII., p. 468, 1855.

H. quadriseriata Banks. Insects, etc., Commander Isl., 1899, p. 349.
Glinka, Copper Isl.

H. trinebulosa Riley. Hubbard's Orange Insects, 1885, p. 216.

Genus Neoliodes Berlese.

Neoliodes Berlese. Bull. Soc. Ent. Ital., Vol. XX., 1888, p. 47.

N. concentrica Say. Jour. Phila. Acad., Vol. II., 1821, p. 73.
Under bark of elm-tree, Washington, D. C.; Enterprise, Fla.; and from Pennsylvania.

N. floridensis Banks. Proc. Acad. Nat. Sci. Phila., 1906, p. 499.
Lake Worth, Fla.

Genus Tumidalvus Ewing.

Tumidalvus Ewing. Ent. News, Vol. XIX., 1908, No. 6, p. 243.

T. americana Ewing. Ent. News, Vol. XIX., 1908, No. 6, p. 244.
In moss, Arcola, Ill.; in rubbish, Columbia, Mo.

Genus Cymbæremæus Berlese.

Cymbæremæus Berlese. Acari, Myr., Scorp., Fasc. LXXVIII., 1896.

C. marginalis Banks (*Eremæus*). Trans. Amer. Ent. Soc., Vol. XXIII., 1896, p. 76.
On bark, Sea Cliff, N. Y.

Genus Nothrus C. L. Koch.

Nothrus C. L. Koch. Crust. Myr. Arach., Heft 2, 1835.

N. banksi Michael. Das Tier., Lief. 3, 1898, p. 70.
Olympia, Wash.

N. bipilis Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 14.
From *Sphagnum*, Sea Cliff, N. Y.

N. excisus Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 15.
On the bark of spruce-trees, Sea Cliff, N. Y.

N. rugulosus Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 15.
Under bark, Sea Cliff, N. Y.

N. simplex Banks. Jour. N. Y. Ent. Soc., 1895, p. 130.
From wet *Sphagnum*, Roslyn, N. Y.

N. taurinus Banks. Proc. Acad. Nat. Sci. Phila., 1906, p. 499.
Falls Church, Va.

N. truncatus Banks. Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 14.
From *Sphagnum* and in moss, Sea Cliff, N. Y.

Genus Hypochthonius C. L. Koch.

Hypochthonius C. L. Koch. Crust. Myr. Arach., Heft 3, 1835.

H. rufulus C. L. Koch. Crust. Myr. Arach., Heft 3, Tab. 19.
Arcola, Ill.

Family HOPLODERMIDÆ.

Genus HOPLODERMA Michael.

Hoploderma Michael. Das Tier., Lief. 3, 1898, p. 77.

H. dasypus Ant. Dugès (*Oribates*). Ann. Sci. Nat., Sér. 2, Vol. II., p. 47.
In decayed wood, Arcola, Ill.

H. granulatum Banks. Can. Ent., Vol. XXXIV., 1902, p. 175.
Ottawa, Canada.

H. setosum Banks (*Hoplophora*). Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 16.
On the ground, Sea Cliff, N. Y.

H. sphærulum Banks (*Hoplophora*). Trans. Amer. Ent. Soc., Vol. XXII., 1895, p. 16.
Sea Cliff, N. Y.

Genus PHTHIRACARUS Perty.

Phthiracarus Perty. Allg. Naturg., III., 1841, p. 874.

P. americanus, n. sp.
Under logs and old boards, Danville, Arcola, and Urbana, Ill.

P. arctatus Riley (*Hoplophora*). Riley's 6th Mo. Rep., 1874, p. 53.
Sea Cliff, N. Y.; Florida; Missouri.

P. cryptopus Banks. Proc. Calif. Acad. Sci., Ser. 3, Vol. III., 1904, p. 367.
Claremont, Calif.

P. flagelliformis, n. sp.
Under logs, Homer, Ill.

P. flavus Ewing. Ent. News, Vol. XIX., p. 450.
In moss, Urbana, Ill.

P. glabratus Say. Jour. Phila. Acad., Vol. II., 1821, p. 73.
Sea Cliff, N. Y.

P. magnus Ewing. Psyche, Vol. XIV., 1907, p. 114.
Under old logs, Pine, Ind.

P. rotundus Ewing. Ent. News, Vol. XIX., p. 451.
Under a log, Batavia, Ill.

EXPLANATION OF PLATES.

Plate XXXIII.

Fig. 1. *Oribata spinogenuala*, n. sp., × 34; 1*a*, pseudostigmatic organ; 1*b*, bristle on the tip of the genual of leg II; 1*c*, anal and genital covers.

Fig. 2. *Oribata artilamellata*, n. sp., × 34; 2*a*, pseudostigmata and pseudostigmatic organ.

Fig. 3. *Oribata illinoisensis*, n. sp., × 58; 3*a*, pseudostigmata and pseudostigmatic organ.

Fig. 4. *Oribata robusta* Banks, × 34; 4*a*, pseudostigmata and pseudostigmatic organ; 4*b*, anal and genital covers.

Plate XXXIV.

Fig. 5. *Oribata virginica* Banks, × 58; 5*a*, pseudostigmata and pseudostigmatic organ.

Fig. 6. *Oribata parvilamellata*, n. sp., × 34; 6*a*, pseudostigmata and pseudostigmatic organ; 6*b*, ventral surface.

Fig. 7. *Oribata octopunctata*, n. sp., × 58; 7*a*, pseudostigmata and pseudostigmatic organ.

Fig. 8. *Oribata minuscula* Banks, × 34; 8*a*, pseudostigmata and pseudostigmatic organ; 8*b*, anterior ends of lamellæ and the translamella.

Fig. 9. *Liacarus lucidus*, n. sp., × 58; 9*a*, pseudostigmata and pseudostigmatic organ.

Plate XXXV.

Fig. 10. *Liacarus minutus*, n. sp., × 58; 10*a*, pseudostigmata and pseudostigmatic organ.

Fig. 11. *Liacarus niger*, n. sp., × 34; 11*a*, pseudostigmata and pseudostigmatic organ.

Fig. 12. *Notaspis pyrostigma*, n. sp., × 58; 12*a*, pseudostigmata and pseudostigmatic organ; 12*b*, palpus and mandible.

Fig. 13. *Phthiracarus flagelliformis*, n. sp., × 34; 13*a*, pseudostigmata and pseudostigmatic organ; 13*b*, mandible; 13*c*, distal end of tarsus of leg I.

Fig. 14. *Phthiracarus americanus*, n. sp., × 34; 14*a*, pseudostigmata and pseudostigmatic organ; 14*b*, distal end of tarsus of leg I.

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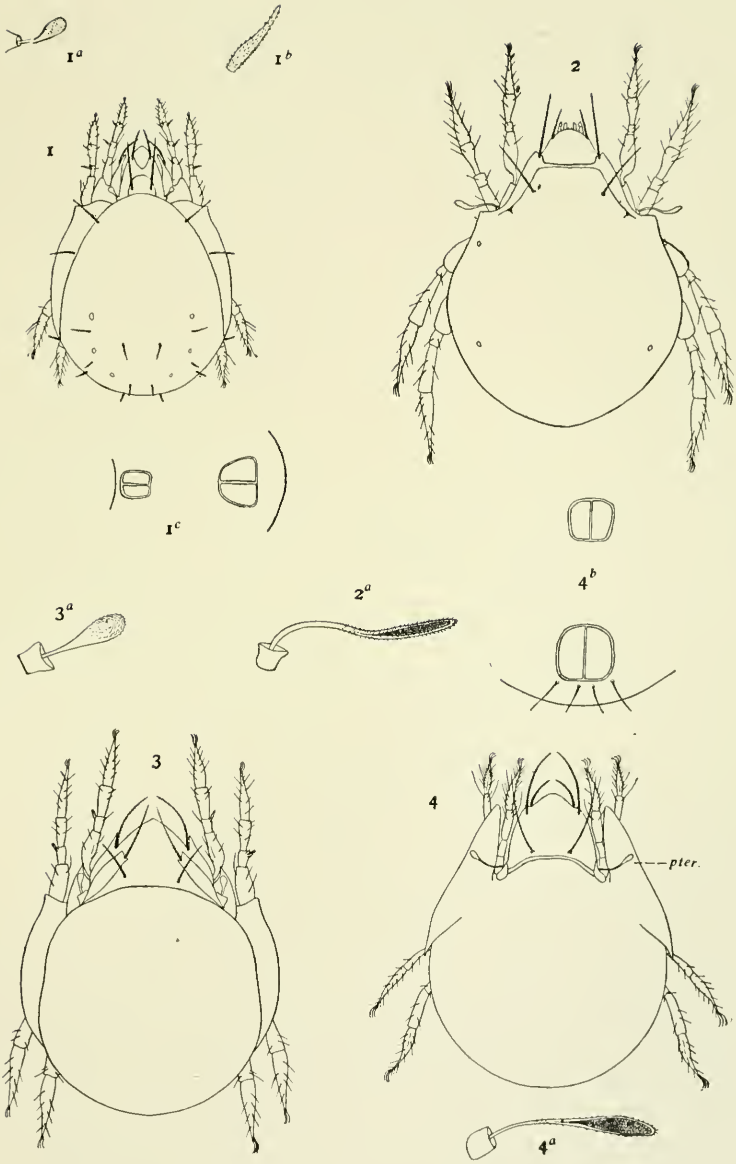
ERRATUM.

Page 378, line 1, for *XXV.* read *XXXV.*

XXXIII.



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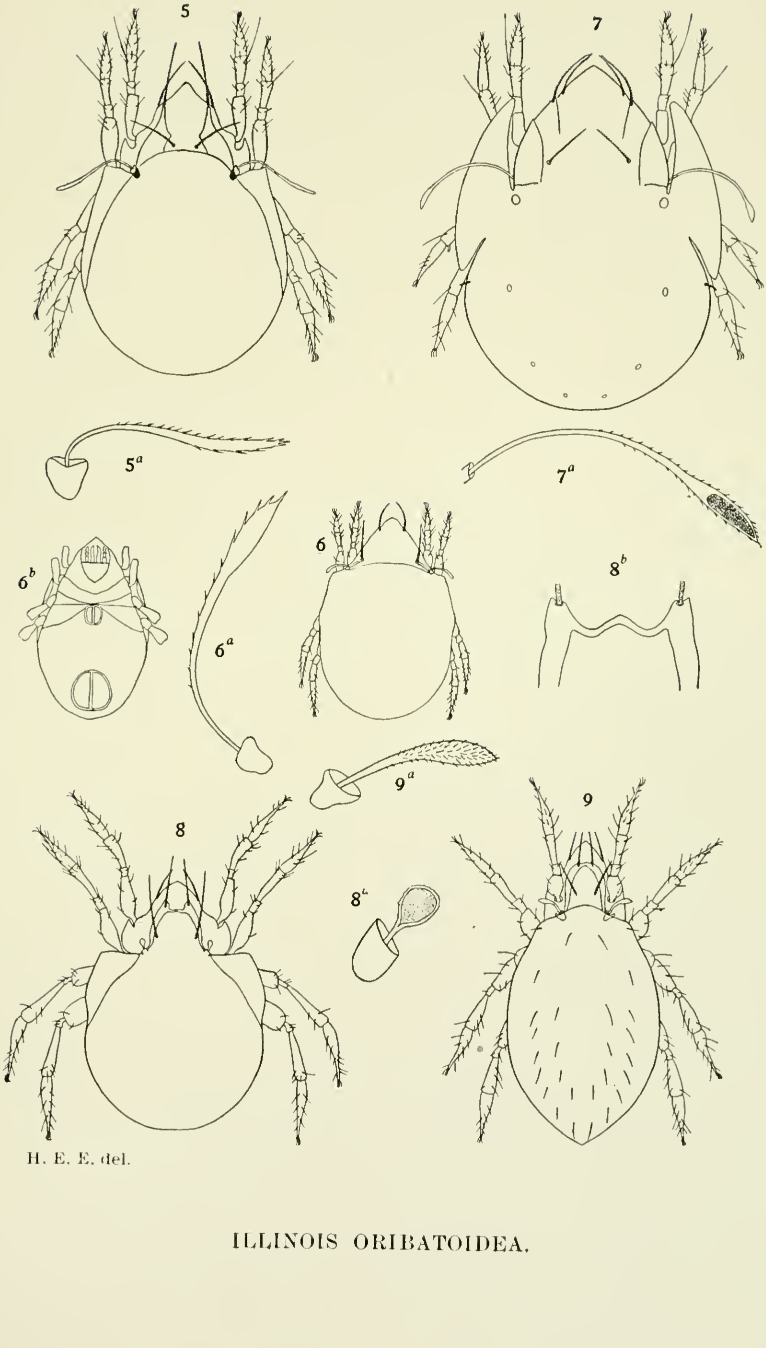
ILLINOIS ORIBATOIDEA.



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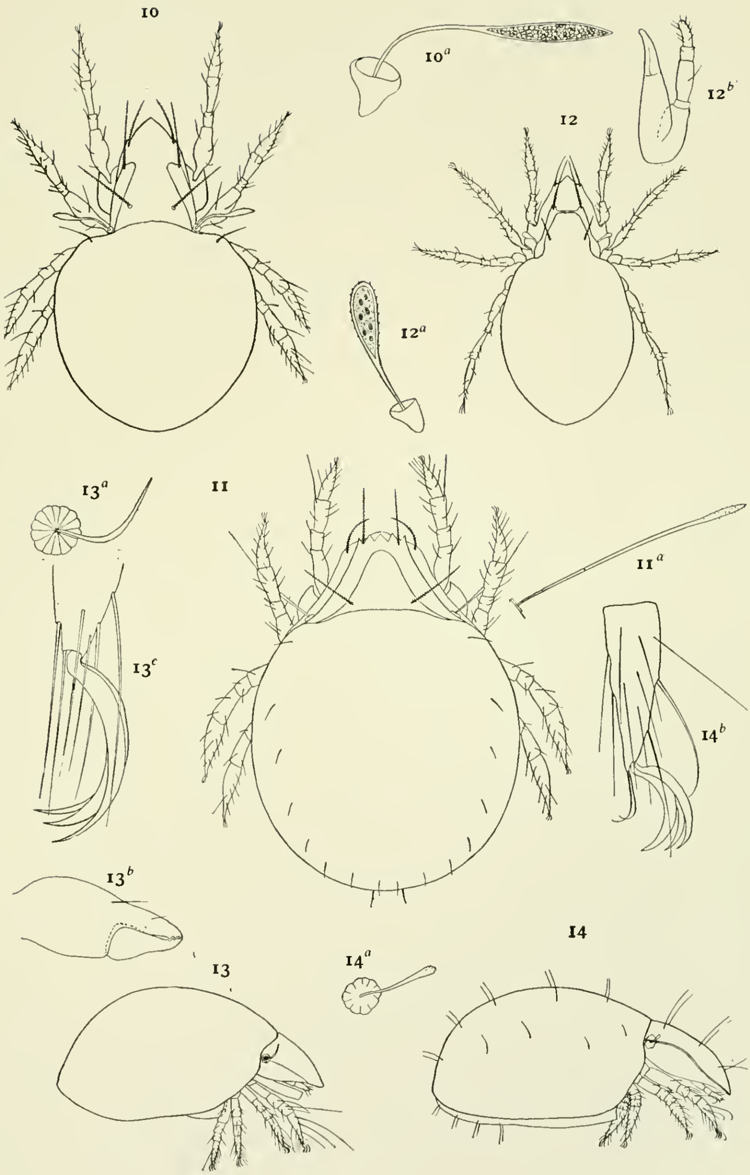

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